THE QUARTERLY REVIEW OF BIOLOGY

SEPTEMBER
1954

Vol. 29 No. 3

Published by
THE WILLIAMS & WILKINS COMPANY
BALTIMORE, U. S. A.

Copyright 1954
THE WILLIAMS & WILKINS COMPANY

THE QUARTERLY REVIEW OF BIOLOGY

FOUNDED BY RAYMOND PEARL

B. H. WILLIER, *Editor*
The Johns Hopkins University

H. BENTLEY GLASS
Associate Editor

CARL P. SWANSON
Assistant Editor

Advisory Board

IRVING W. BAILEY ..... *Harvard University*
G. W. BEADLE ..... *California Institute of Technology*
DAVID R. GODDARD ..... *University of Pennsylvania*
ROSS G. HARRISON ..... *Yale University*
LIBBIE H. HYMAN ..... *American Museum of Natural History*
A. L. KROEBER ..... *University of California*
K. S. LASHLEY ..... *Harvard University*
CHARLES W. METZ ..... *University of Pennsylvania*
THOMAS PARK ..... *University of Chicago*
G. H. PARKER ..... *Harvard University*
ALFRED S. ROMER ..... *Harvard University*
ALEX. G. RUTHVEN ..... *University of Michigan*
F. O. SCHMITT ..... *Massachusetts Institute of Technology*
PAUL WEISS ..... *University of Chicago*

Papers to Appear in an Early Number

PHOTOORIENTATION AND THE "TROPISM THEORY"

Harold F. Blum, *National Cancer Institute* and *Princeton University*

FAUNAL REALMS, REGIONS AND PROVINCES

Karl P. Schmidt, *Chicago Natural History Museum*

POLYSPERMY

Lord Rothschild, *Department of Zoology, Cambridge University*

Entered as second-class matter January 27, 1926, at the post office at Baltimore, Maryland, under the act of March 3, 1879.
Subscription price $6.00 a year ($6.50 outside Postal Union) $1.75 a copy.
Made in United States of America

VOL. 29, NO. 3 September, 1954

THE QUARTERLY REVIEW of BIOLOGY

MORPHOGENESIS IN PROTOZOA

By PAUL B. WEISZ

Department of Biology, Brown University

INTRODUCTION

IN 1769, Ellis published a report that fragments of ciliates, found fortuitously in infusions, continued to live indefinitely. During the ensuing century, many other microscopists (cf. Balamuth, 1940) made analogous observations for a wide variety of protozoa: mutilated animals would survive, chance fragments would persist for long periods. In most of the very early accounts, regeneration was not yet recognized as a problem in its own right. For example, Ehrenberg (1838) still interpreted his data as evidence for protozoan reproduction by means of eggs, in line with spermist and related theories of an earlier day. Similarly, other observers, while more or less casually noting the survival of fragments, made no reference to regeneration.

But an issue of morphogenesis gradually crystallized. In 1841, Dujardin expressed the belief that if ciliates could be cut into pieces, each piece would grow into a complete animal. A more cautious—and, by hindsight, more prophetic—stand was taken by Claparède and Lachman (1858), who doubted whether a whole individual could form from every kind of fragment. Webb (1855) was one of the first to interpret events after mutilation specifically as regeneration, and during the following years, deliberate experimental studies began to appear (e.g., Stein, 1859; Greeff, 1867; Schneider, 1867; Cienkowski, 1873). Thus the stage was slowly set for the first concerted attack on what still remained an essentially new problem: protozoan development. This attack came in the 1880's with the pioneer work of Bütschli, Balbiani, Verworn, Gruber, and others, almost at the same time when Roux began his investigations into amphibian morphogenesis.

Since then, experimental and conceptual probings into mechanisms of morphogenesis have been undertaken extensively. The center of interest was, and to a considerable extent still is, the metazoon. While in frogs embryologists could find living evidence for such advanced abstractions as regulation, determination, induction, and fields, protozoologists could do little more than demonstrate that protozoa did in fact exhibit morphogenesis: viewed in retrospect, there was success primarily in showing what occurs, less success in showing how it occurs. In this work, ciliates quite properly ranked as the favorite objects of inquiry. Their manifold, relatively permanent differentiations, their nuclear dichotomy, and often their large size, made ciliates the logical test organisms for the phylum as a whole. Ciliates thus became to protozoan morphogenesis what amphibia were to metazoan morphogenesis. This review will reflect the sustained preoccupation with ciliates.

Today the analytic approach to morphogenetic problems in protozoa is well under way. Also, as issues of metazoan embryology come to revolve more and more around molecular and cellular

phenomena, attention turns increasingly to microorganisms as research material. As a result of these fairly recent developments, a common ground is being found for all expressions of morphogenesis: clothed though it may be in differing costumes, the essence of developmental processes appears to be one, in all living things.

In protozoa, morphogenetic events may be grouped descriptively into five broad categories:

1. *Regeneration:* restorative events producing organismic wholeness following major surgical interference.

2. *Reorganization:* restorative events elicited by a wide variety of natural or experimental stimuli, e.g., unfavorable culture conditions, mild physical, chemical, or physiological injury, encystment and excystment, and sexual processes.

3. *Reproduction:* the elaboration of two or more whole organisms from one, preceding fissional cleavage or budding.

4. *Teratomata:* the formation of monsters, chimerae, fusion systems, and of abnormal morphologies generally, either fortuitously in culture, or by experimental means.

5. *Cyclic development:* the formation of embryos, of colonies, of distinct morphological stages in parasitic forms; in general, the category of specialized structural adaptations exhibited in the course of complex life cycles.

This review will deal specifically with the first four categories only. Phenomena included under the fifth have, in a few cases, been reducible to processes also observed in the first four. In the majority of such cases, however, extensive studies have not yet been undertaken.

CONDITIONS FOR MORPHOGENESIS

Regeneration

Primary Conditions: the Environment

Protozoan morphogenesis appears to be limited by few external factors that do not also limit developmental processes in other living organisms. For example, variation in rate of regeneration with temperature is well established (e.g., Morgan, 1901b; Weisz, 1948a). So is the influence of pH and various ion balances (e.g., Balbiani, 1899; Sokoloff, 1924; Chejfec, 1932). By and large, however, these are preliminary investigations: the fine links between morphogenesis and the physical chemistry of the culture medium have as yet been explored very little.

The role of nutrition in regeneration (and morphogenesis generally) has also received little searching attention. Wallengren (1902) was probably the first to describe events during prolonged starvation. The pattern he observed for *Paramecium caudatum* (viz., progressive vacuolation, resorption of cilia, nuclear fragmentation, followed by irreversible degenerative changes and death) was later found to hold for protozoa generally. Before final structural degeneration becomes evident, a point is usually reached after which regeneration no longer occurs (e.g., *Paramecium*: Peebles, 1912; Chejfec, 1932; *Uronychia*: Young, 1922; *Spathidium*: Moore, 1924; *Bursaria*: Sokoloff, 1923, 1924). In *Stentor coeruleus*, Weisz (1948b) found this point to coincide with the disappearance of carbohydrate reserves. As long as stored carbohydrates were available, regeneration took place and the reserves were used up in the process. But in the absence of carbohydrate stores, regeneration did not begin even in the presence of stored fat. A potentially interesting observation was made by Sokoloff (1924), who showed that slightly starved *Bursaria* regenerated better than well fed ones. In the same vein, Chejfec (1932) reported a higher incidence of postoperative recovery in *Paramecium* fragments if the animals had been slightly starved. The significance of these findings is not clear.

Considering the paucity of such data, the need is manifest for detailed studies which would relate specific morphogenetic reactions to precise nutritional requirements. Indeed, this appears to be one of the most promising lines of future research. Forms in which dietary factors are already reasonably well understood and can be adequately controlled (e.g., *Tetrahymena*) seem particularly suited for work of this kind.

The general vigor of a culture may be a limiting factor in regeneration. In cultures of *Paramecium caudatum*, Calkins (1911b) and Peebles (1912) noted occasional periods of depression during which fragment regeneration (as well as fission) was impaired, or did not occur at all. It is far from clear what a depressed culture actually is, and hence it is difficult to analyze such failures of morphogenesis. Among other protozoa, depression due to unfavorable culture media may elicit reorganizational processes (v.i.).

Another limiting condition came to light rather indirectly. Balbiani (1883), Jennings (1908), Calkins (1911b), Chejfec (1932), Hosoi (1937),

and others, were impressed by what appeared to be a consistently poor regeneration capacity of *Paramecium*. Peebles (1912) was the first to take special note of the physiological conditions of the animals used: she found that merozoa with viscid cytoplasm usually regenerated, while highly solated fragments soon cytolyzed. The extensive analysis (over 800 tests) of Tartar (1939) drove this point home. When discounting all cases of non-recovery after cutting, he found that 98 per cent of the remaining cases regenerated successfully. *Paramecium* evidently is not an exceptional ciliate (as some had previously claimed); it illustrates, rather, that proper wound healing is a necessary prerequisite for regeneration.

Cytoplasmic viscosity is not the only factor of importance in wound healing. Sokoloff (1924) noted that *Bursaria* and *Spirostomum* fragments did not regenerate if they were insufficiently covered by original pellicle. A similar condition was found to hold for *Stentor* (Weisz, 1948a). If only a comparatively small surface area (i.e., less than half) of a fragment was protected by original ectoplasm, the exposed surface precipitation membrane over the remainder either did not contain the wound at all, or did not prevent the gradual development of excessive vacuolation. This led to death before a new pellicle could be regenerated.

Primary Conditions: the Nuclear Apparatus

That nuclear material is essential for regeneration was first clearly stated by Brandt (1877), on the basis of his work on *Actinosphaerium*. Thereafter a voluminous literature accumulated rapidly, extending Brandt's conclusion to all protozoan groups (cf. review by Balamuth, 1940). By 1909, the year when the term "gene" appeared in biology, protozoologists had already recognized nuclear involvement as a central principle, to be taken into account in any theory of morphogenesis.

The question as to which of the two types of nuclei is necessary for regeneration (and morphogenesis generally) can be answered with the following fairly well documented generalizations (see also Balamuth, 1940):

1. Micronuclei alone are never sufficient for regeneration in any group.

2. Macronuclear substance is essential in all ciliates.

3. Macronuclear substance alone suffices in all heterotrichs so far tested.

4. In most holotrichs and some hypotrichs tested, macronuclear substance alone suffices for organelle replacement per se. But micronuclei contribute an essential viability, without which a regenerant succumbs after a few divisions.

5. In all other hypotrichs tested, micronuclear as well as macronuclear substance is required for any morphogenetic event. It is not known whether the micronuclei contribute to organelle replacement specifically, or whether they merely contribute to viability, as above, absence of this factor simply being of more immediate consequence here than in (4).

6. Work on peritrichs and suctoria is still too scant to permit any generalizations beyond (1) and (2). (Seshachar and Dass, 1953, have stated that if a dividing individual of the peritrich *Epistylis articulata* was accidentally deprived of its macronucleus, then a new macronucleus developed from the micronucleus.)

In all ciliates in which the macronucleus can be fragmented, a small active portion has always been found to suffice for regeneration. This holds not only for forms with elongate or beaded macronuclei, but also for types with normally compacted nuclei. Thus Lewin (1910) cultured amicronucleate fragments of *P. caudatum* containing only pieces of the macronucleus. Sonneborn (1946) obtained fully viable clones of *P. aurelia* in which all macronuclear material was derived from a small fragment of a skeined reorganization nucleus present in a parent animal. Data of this sort have given rise to the now generally accepted view that the ciliate macronucleus is composed of many subnuclei, each of them representing at least one complete genome. By comparing the DNA content of micronuclei and macronuclei, Moses (1950) estimated the macronucleus of *Paramecium* to contain about 40 subnuclear units. Nanney's recent work (1953a) suggests that such units may display various states of ploidy. (That individual micronuclei may be polyploid was shown, for example, by Chen, 1940, for two species of paramecia.)

Macronuclear subnuclei perpetuate by self-duplication. An original subnucleus is formed from the synkaryon during conjugation, and rapid reproduction of this parent nucleus is accompanied by a rapid increase in chromatin concentration (Weisz, 1950a; Seshachar, 1950, 1951; Dass,

1953). Seshachar believes that the old disintegrating macronucleus contributes raw materials to this chromatin (DNA) synthesis. Young primordial nuclei, still containing little chromatin, fail to support regeneration (Weisz, 1950a). Supernumerary primordia are usually formed in *Blepharisma*, and are normally soon resorbed. But if by experimental means a single primordium is made the sole macronuclear element of a separate fragment, then this primordium develops into the definitive macronucleus of the regenerant. This points to a metabolic competition, in the normal animal, among originally equipotential primordia, and tends to explain why normal animals possess only a single nuclear complement. The competition probably involves raw materials required for chromatin (DNA?) synthesis.

In view of the subnuclear makeup, it is simplest to suppose that *any* fragment of a fully formed macronucleus is functionally equivalent to a whole macronucleus. At first glance, most regeneration studies implicitly tend to support this hypothesis. But several lines of evidence indicate that a more careful analysis may be required before any generalization can be made. For example, Tartar (1938) found regeneration time in *Condylostoma* to be a function of macronuclear volume. Here, evidently, a piece of nucleus may not be equivalent to a whole nucleus. In the same vein, studies on *Stentor* (Weisz, 1949b) indicated that macronuclear nodes were functionally equivalent only during early stages of a vegetative cycle. In late stages, posterior nodes progressively failed to support fragment regeneration, and failed also to maintain differentiated organelles in otherwise whole animals. The more posteriorly a node was situated, the less "active" it became in late stages. Thus just prior to fission, midnodes, when isolated into fragments, still supported a partial regeneration of oral structures; but isolated hindnodes no longer sustained stomatogenesis to even that extent. Full activity was found to be restored throughout the macronuclear substance after nuclear condensation during fission. An analogous pattern was traced in *Blepharisma* (Weisz, 1949c), in which a decline of morphogenesis-sustaining activity was found to be accompanied by gradual resorption of the affected nodes (cf. also Young, 1939). In both *Stentor* and *Blepharisma*, the functional fate of a node was shown not to be predetermined by intranuclear factors, but appeared to be correlated with the position of the node within the animal: close proximity to highly differentiated organelles favored maintenance of morphogenesis-sustaining potentials, whereas a position distant from highly differentiated organelles favored functional decline. Rather similar variations in nuclear activity with positional variation of the nuclei were also observed recently by Nanney (1953b) in *Tetrahymena*.

In the light of these considerations, it clearly cannot be generalized that any macronuclear piece functions like every other piece, or like a whole nucleus, at every cycle stage, or at any position, in every ciliate. On the other hand, it is still quite unclear how the makeup of chromatin—hence its functional potential in morphogenesis—might be affected by variations in nuclear mass, position, or cycle stage. On the basis of methyl green staining reactions in macronuclear nodes, Weisz (1950b) described a parallelism between variations in morphogenesis-sustaining activity and variations in the degree of DNA polymerization. Whether such a parallelism has causal significance is questionable, and whether the methyl green technique is a reliable tool for precise DNA analysis is now questionable also (cf. Alfert, 1952). The problem of nuclear chemistry in relation to varying nuclear function still remains an open issue.

Primary Conditions: the Cytosome

Of all components of a protozoon, the endoplasm is probably the least rigidly differentiated. Large quantities can be removed without interfering with vital processes, a fact indicating an equipotentiality of all endoplasmic portions. Stimulated by Hertwig (1903, 1908), numerous earlier investigators claimed that morphogenetic events were under the control of, or were at least influenced by, certain N/P ratios (Prowazek, 1904; Popoff, 1908; Ishikawa, 1912; Sokoloff, 1924; Phelps, 1926; Causin, 1931; et al.). Hypotheses along these lines have never contributed significantly to morphogenetic theory, and have in most cases been proved untenable (e.g., Taylor and Farber, 1924; Burnside, 1929; Schwartz, 1935; Weisz, 1949a). Over a decade ago, the "Kernplasmaverhältnis" problem in the sense of Hertwig was already regarded as a dying issue (Summers, 1941); today it is such.

Probably the most signal advance since the days of Balbiani and Gruber is the elucidation of the role of the infraciliature in ciliate develop-

ment. Chief credit for this goes to Chatton, Lwoff, and Fauré-Fremiet, whose extensive work (reviews cited in literature) has opened up a new rich area of protozoology, and at the same time has pointed the way to an experimental inquiry into morphogenetic mechanisms. What is the infraciliature, and to what extent does it contribute to minimum conditions for regeneration?

In the terminology of Chatton and Lwoff (1935), the infraciliature of a ciliate consists of subpellicular ectoplasmic granules and fibrils. The basal granules of cilia form Chatton and Lwoff's "kinetosomes." A row of kinetosomes is paralleled on the right ("rule of desmodexy") by an associated filament, the "kinetodesma." By electron-microscopic studies on *Paramecium*, Pitelka and Metz (1952) and Metz, Pitelka, and Westfall (1953) showed that a kinetodesma consisted of a bundle of parallel fibrils, each fibril connecting to a kinetosome at one end and ending freely within the kinetodesma at the other. Kinetosdesma and kinetosomal row together represent a "kinety," and the sum total of all kineties in the organism forms the infraciliature (Fig. 1).

The fundamental contribution of the French protozoologists is their recognition that kinetosomes function as pluripotent morphogenetic agents. How this function is specifically exercised will appear in the course of this review. Here it may be noted that the granules are self-duplicating, and that new kinetosomes formed by granular division (1) may contribute to the perpetuation of the generating kinety; (2) may contribute to the lengthwise growth of the generating kinety; (3) may contribute to the formation of new kineties, interpolated between existing ones; or (4) may take part in surface morphogenesis. With regard to the latter, kinetosomes are now believed to influence the development, and to control the functional maintenance, of: cilia, trichocysts, flagella, membranelles, undulating membranes, and cirri (Lwoff, 1949, 1950); and of gullets, contractile vacuoles, and holdfast organelles (Weisz, 1951a). A kinetosome appears to function either as a building block in the formation of a given structure (e.g., trichocysts), or as a director, a "local organizer," in the building process (e.g., cilia). After reviewing the known functions of the infraciliature, Weisz (1951c) sums up: "... (available data tend) to bear out the conclusion that most, if not all, differentiations of the ectoplasmic cortex owe their origin and maintenance to the kinetosomes. . . ."

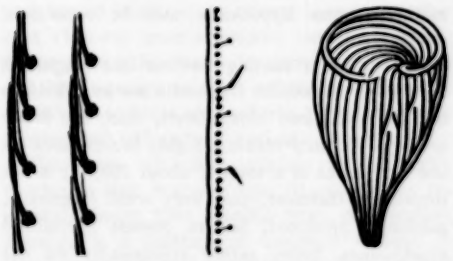

FIG. 1. DIAGRAM OF COMPONENTS OF THE INFRACILIARY SYSTEM. VENTRAL VIEW

Left figure: portions of two kinetal rows, as seen in the electron microscope; fibrils attached to kinetosomes form kinetodesma to the left (after Metz, Pitelka, & Westfall). *Center figure:* silver preparation of a kinety, as seen in the light microscope; kinetodesma on the left, row of kinetosomes on the right; daughter granules divided off from some kinetosomes, differentiating as trichocystosomes (after Lwoff). *Right figure:* the disposition of kineties in *Stentor coeruleus*; peristome and gullet anteriorly (after Weisz).

A second finding of the French investigators is particularly significant. In most ciliates, certain kinetosomes appear to be uniquely specialized, and to hold a dominant position within the infraciliature. The location of these kinetosomes varies among species according to distinct patterns, discussed below. The specialized status of these granules is indicated by the observation that they, and only they, normally initiate, direct, and sustain major morphogenetic events (e.g., stomatogenesis). This specialized status is perpetuated, in an unbroken chain of kinetosomal generations, through successive protozoan generations.

Thus the presence of at least some specialized kinetosomes appears to be a necessary prerequisite for regeneration. Hence much of the earlier work in protozoan morphogenesis may require reappraisal and reinvestigation in the light of this newer knowledge.

Derivative Conditions

Given an adequate environment, an active nuclear apparatus, and a functioning infraciliary complement, then regeneration can occur. But this constellation of factors is not always encountered in every merozoon, or under all conditions. As these three primary conditions vary, they produce "derivative" conditions for regeneration. Among these are species and racial strain, body level, fragment size, and cycle stage.

In earlier literature, all these conditional factors have been "explained" by reference to varying "regeneration capacities." However, what is required is not a restatement of the observation under the guise of a new term, but rather an analysis which would reveal all variations in regenerative behavior as functions of the three primary conditions above.

A case in point is the supposedly "varying regeneration capacity" of different protozoan species. There probably exists no justification for assigning "poor powers of regeneration" to sporozoa and other parasitic types, simply because the very few tests so far performed largely yielded negative results (e.g., Nussbaum, 1884, 1886; Dembowski, 1913; Joff, 1923; Sokoloff, 1924). As Balamuth (1940) pointed out, culture conditions in these experiments were usually inadequate—Sokoloff, for example, was unable to rear even normal whole animals—and conclusions regarding regeneration are therefore premature. In other cases, non-regeneration is more reliably documented. For example, among shelled Sarcodina like *Difflugia* and *Arcella*, mutilated shells remain in an imperfect state and do not regenerate (Verworn, 1888; Penard, 1900; Martini, 1905; Hegner, 1920; Okada, 1930). Yet to imply that these animals lack intrinsic regeneration "capacity" would be as unwarranted as amputating a frog limb and denying regeneration capacity there. If regeneration work has shown anything, it has demonstrated beyond question that ability to regenerate is practically a phylum characteristic of protozoa—as indeed of all living organisms. Manifestly, intrinsic capacities may sometimes be blocked, presumably by particular constellations of primary conditions. This is what the experimenter must uncover. But there is nothing in the literature which does not support the conclusion that intrinsic regeneration capacity exists always, implicitly, and virtually by definition of "living organism"; and that, depending on the type of organism, it may be more or less difficult for this implicit capacity to become explicit process. The species of protozoa used does *not* constitute an inherent limiting condition for regeneration.

This holds true also for racial strain within a species. Calkins (1911b) and Peebles (1912) described greatly varying "regeneration capacities" for various strains of *Paramecium*, and Reynolds (1932) arrived at similar conclusions for two varieties of *Euplotes*. However, Tartar (1939, also v.s.) showed that results in *Paramecium* could be explained without recourse to regeneration capacities, by simply taking into account the differential ease of wound healing in different races. And Reynolds herself indicated that the so-called "non-regenerating" variety of *Euplotes* never survived the operation. Clearly, no new factors beyond the three primary ones need be postulated to account for varying regeneration potentials.

Ever since Lillie (1896) and Morgan (1901) shook stentors into pieces, it has been somewhat of a pillar of morphogenetic theory that fragments below a certain volume were incapable of regeneration (see also pertinent work by Moore, 1924; Sokoloff, 1923, 1924; Phelps, 1926). The best explanation was that critical regeneration volumes represented the minimum mass with which an organism of given complexity could be constructed. At first glance, this seems to be a reasonable hypothesis. It may be noted, however, that all critical volumes determined in earlier work were expressed as functions of the volume of the original whole animal. Thus Morgan found $\frac{1}{64}$th of the whole animal to be the critical volume for merozoa of *Stentor coeruleus*. But stentors in a well fed culture have a greater average size than animals with poorer food supplies; also, size varies considerably with cycle stage. Accordingly, it should take less protoplasm to construct a stentor in one culture dish than in another, and similarly when the fragment derives from an early-stage individual. This is manifestly not the case, and the minimum mass hypothesis must be considered untenable.

In shaking or cutting stentors into fragments randomly, the smaller fragments are less likely to contain specialized kinetosomes, since the latter are deployed only within a highly limited area (in one kinety out of a total of about 100). It is not surprising, therefore, that very small fragments, randomly produced, seldom possess specialized kinetosomes, hence rather consistently do not regenerate; and that values for "minimum volumes" turn out to be relatively fixed fractions of the original whole volumes. A reexamination of the problem (Weisz, 1951a, and unpub.) actually shows that fragments as large as, or larger than, one-half of the whole animal do *not* regenerate if all specialized kinetosomes are excised; but that fragments as small as, or smaller than, $\frac{1}{100}$th of the whole animal (i.e., twice as small as Morgan's

"minimum") *do* regenerate if care is taken that appropriate kinetosomes are present.

Certainly there exists a *practical* minimum volume: a fragment which just barely accommodates a single nuclear node and a thin shell of surrounding cytoplasm. This volume can be expressed in absolute terms, and is independent of the size of the original animal. But even this is probably not a *theoretical* minimum. True "critical" volumes are not likely to be reached until the last nucleoprotein molecule has submitted to merotomy. It may be concluded that a size factor, in the sense of Lillie and Morgan, is not a limiting condition for regeneration. As with species and race, no new condition beyond the three primary ones need be introduced to account for published data.

A closer analysis is also in order in the few cases where "regeneration capacities" have been said to vary with body level, and with fragment volume beyond the "critical" one. For example, Sokoloff (1923) recorded minimum regeneration volumes of $\frac{1}{53}$, $\frac{1}{68}$, and $\frac{1}{69}$ for anterior, middle, and posterior fragments of *Spirostomum*, respectively. He concluded, essentially, that regeneration capacities varied with body level. An analogous interpretation is at least implied by investigators who obtained higher regeneration percentages in anterior merozoa than in posterior ones (e.g., Peebles 1912, for *Paramecium*). First, it is to be questioned whether Sokoloff's data are statistically significant, and whether Peebles' data might not largely reflect conditions of viscosity and wound healing (v.s.). Second, even granting that clear-cut antero-posterior regeneration differentials can be shown to exist, then it would still be necessary to show whether anterior and posterior fragments are equivalent with respect to kinetosomal and, indeed, nuclear complements.

The same objection applies to Sokoloff's conclusion that, because larger fragments may regenerate faster than smaller ones, regeneration capacity is a function of fragment volume. A larger fragment might simply possess a greater quantity of raw materials (including specialized kinetosomes and active nuclei), a condition which might well entail a shorter preparatory period prior to the visible onset of organelle replacement. These considerations do not rule out the possibility that, in given species, body level, fragment volume, or both, might influence the course of regeneration (even though an unassailable case of this kind has yet to be recorded); they imply, rather, that specific primary conditions, not differential "regeneration capacities," are to be sought in explanation.

An analysis of primary conditions has already begun in connection with another supposed limiting factor in regeneration, that of cycle stage. Calkins (1911a) found that fragments of *Uronychia* regenerated best if merotomy was performed just before fission; least, if just after fission. Tartar (1939), reexamining Calkins's data, pointed out that what was actually shown was that prefission animals could regenerate without the micronucleus, while postfission animals could not. A micronuclear contribution to morphogenesis was thus suggested: the micronucleus could apparently be dispensed with after its contribution is emitted into the cytoplasm (i.e., at prefissional stages). Several other investigators, working on a variety of hypotrichs, confirmed Calkins's findings (*Uronychia*: Young, 1922; Dembowska, 1926; Taylor, 1928; *Oxytricha*: Reynolds, 1932; Bauer and Granjowskaja, 1934a, b; *Gastrostyla*: Bauer and Granjowskaja, 1934a, b). Taylor was probably the first to attempt an explanation beyond restating the problem in terms of regeneration capacities. He theorized that fission (as well as other morphogenetic events) might involve profound reorganizations on the molecular level, leading to "physiological rejuvenescence," i.e., to increased metabolic efficiency. This would differentiate young and old stages, and their different behavior in regeneration might somehow be an expression of this physiological difference. Following this line of thought, Bauer and Granjowskaja tried to find evidence for such rejuvenation. They were able to establish three points: (1) nuclear reorganization (i.e., as in physiological regeneration, v.i.) occurred only in old stages; (2) old stages exhibited a greater respiratory rate than young stages; (3) repeated merotomies could suppress and replace fission for many generations, but only if the transections were performed after the regenerants had grown to old stages, of large size: successive transections of small young regenerants soon led to their death. It may be concluded that different cycle stages in these hypotrichs are indeed differentiated physiologically, and that this is apparently due to cyclical variations in micronuclear and macronuclear activity. It still remains to be shown, however, how this would affect the mechanism of regeneration. The suggestion of nuclear cycles

here finds a probable parallel in the nuclear cycles of *Stentor* and *Blepharisma* (v.s.).

The discussion above thus supports the general view that regeneration is limited by just three primary conditions. Notwithstanding the extremely diverse regenerative behavior encountered in widely different protozoa, there is probably no case that cannot be reduced to a specific conjunction of environmental, cytosomal, and nuclear conditions—without recourse to other factors. By hindsight this may seem to be a rather elementary conclusion, for if not environment, cytoplasm, and nucleus, what other factors *could* be involved in a cellular phenomenon? This is so; but the very recognition of the principle represents an advance in protozoology. In the past, every regeneration study was virtually a case unto itself, with conditions and problems regarded as largely peculiar only to it. Today the common denominator can be perceived; and this should provide a valuable orientation for future research.

REORGANIZATION AND FISSION

The classical case of reorganization was described by Balbiani (1891). In cultures of *Stentor coeruleus*, individuals could occasionally be found in which the oral structures dedifferentiated without obvious cause, being replaced by newly developed organelles. The nuclear and cytosomal aspects of this seemingly spontaneous reconstitution were remarkably similar to those of regeneration. This process in *Stentor* was later described by several other observers (e.g., Johnson, 1893; Morgan, 1901; Hetherington, 1932; Schwartz, 1935; Weisz, 1949a), and was given a variety of labels: "physiological regeneration," "physiological reorganization," "spontaneous regeneration," "reorganization," etc. Balbiani already noted that culture conditions could influence the incidence of reorganization, but this connection was first examined critically by Hetherington. He found that reorganization never occurred in controlled, optimal cultures. On the other hand, crowding, poor food supplies, mild chemical irritants, small structural lesions or imperfections, and unfavorable culture conditions generally, all are now known to represent fairly direct stimuli for reorganization.

Physiological regeneration occurs in many other protozoa, e.g., *Noctiluca* (Cienkowski, 1873), *Holosticha* (Wallengren, 1901), *Stylorhynchus* (Leger and Duboscq, 1904), *Wagnerella* (Zulzer, 1909), *Bursaria* (Lund, 1917; Schmähl, 1926), *Colpidium* (Klein, 1928), *Glaucoma* (Chatton, Lwoff, Lwoff, and Monod, 1931; von Gelei, 1935), *Nassula* (Chatton and Lwoff, 1936), *Stylonychia* (Dembowska, 1938), and others. At first glance, reorganization in all these instances appears to be spontaneous. But closer analysis shows that, as in *Stentor*, some unfavorable factor in environment, nutrition, or morphology forms an initiating stimulus. As in *Stentor* also, the course of reorganization and the course of regeneration follow virtually identical patterns.

This parallelism gave rise to the supposition (cf. Balamuth, 1940; Weisz, 1949a) that a single morphogenetic mechanism might underlie both processes. This mechanism would be brought into action by one of many possible stimuli. Regardless of whether such a stimulus is drastic merotomy, or some less obvious, but nonetheless injurious interference, the same reparative event would ensue. As will be seen below, this hypothesis has received full confirmation.

It is interesting to note that the very same stimuli which in some protozoa lead to physiological regeneration, initiate encystment and excystment, and/or sexual processes, in others. In all these phenomena, the essential *morphogenetic* events are again virtually identical with those of regeneration. Encystment may be preceded or accompanied by dedifferentiation, and redifferentiation following excystment runs the same course, with the same end result, as regeneration. Similarly, cytoplasmic lesions resulting from the act of mating may lead to dedifferentiation, followed by redifferentiation as in regeneration (cf. Maupas, 1889). The general conclusion emerges (1) that protozoa are readily capable of responding to a wide variety of damaging stimuli; (2) that, depending on the particular species and the particular limiting conditions imposed by the stimulus, responses of different external form are initiated; and (3) that, regardless of the external form, the response includes a species-characteristic repair process which invariably follows a single pattern, which is mediated by a single mechanism (v.i.), and which has a single end result, namely, the reestablishment of a *status quo*.

Fission and budding too might be regarded as responses to "damaging" stimuli, although "damage" here is to be understood in the sense of an alteration of the internal environment, rather than a traumatic lesion. Just three events are unique in fission: mitosis, the division of the macronucleus, and the formation of a fission line

along which cytoplasmic cleavage takes place. All other demonstrable occurrences are morphogenetic in nature, i.e., the elaboration of a double organism from one. And it may be noted that the remarkable similarity of the morphogenetic aspects of fission and of regeneration and/or reorganization struck even the earliest observers (e.g., Gruber, 1885; Morgan, 1901). All of many later investigators who studied fission corroborated this amply, for a wide variety of protozoa (e.g., Dembowska, 1926; Causin, 1931; Reynolds, 1932; Balamuth, 1942; Weisz, 1949a). After reviewing the literature, Balamuth (1940) wrote: "... All the available evidence has indicated that the regenerative process follows the same general course as fission.... Apparently the causal mechanism of reorganization may be stimulated in various ways...." And Weisz (1949a) concluded: "... Regeneration, physiological reorganization, and vegetative division are different and independent phenomena only in the sense of their causation by different environments...." For fission, quite as for reorganization, the underlying morphogenetic mechanism was subsequently shown to be identical with that of regeneration.

A comprehensive generalization thus emerges with regard to the significance of normal morphogenesis in protozoa. Viewed from the standpoint of internal process, all morphogenetic events in a species have a single, common basis; and viewed from the standpoint of external form (e.g., "regeneration," "excystment," "fission," etc.) all morphogenetic events have a single, common adaptive role: steady state control. Protozoa of course possess other controls which maintain them in steady state relative to their environments: locomotion, gullets, defense mechanisms like trichocysts, and internal metabolic machinery. These come into play primarily when environmental stresses are transitory, and rather easily reversible or avoidable. But if environmental effects become more profound, less easily avoidable, and perhaps irreversible, then a *morphogenetic* steady-state device may be brought into action. It can be started off by a multiplicity of stimuli, it involves a partial or complete demolition of the existing morphology, and such a "clearing of decks" is preceded, accompanied, or followed by redifferentiation of a new set or sets of structures. This central event, together with varying accompanying responses (e.g., cyst-shell secretion, conjugation, fissional cleavage, etc.), permits steady-state maintenance under a considerable array of conditions.

It is of some interest to consider that the internal upheaval occasioned by a fixed morphogenetic response is often quite out of proportion to the severity of the stimulus. As is well known, for example, injury to as little as a single hypotrich cirrus leads to the very same profound reorganization that is initiated also by bisection of the whole animal. One suspects that, where routine hazards of living are concerned, steady-state control through morphogenesis is not the most efficient method, particularly when contrasted with the often non-morphogenetic, more adaptable, more proportionate, hence probably more economical response possibilities of a highly evolved metazoon. Indeed, one suspects that morphogenetic capacity has evolved originally as a relatively sure, fool-proof "defense" mechanism —in the widest sense of the word—still largely retained as such by protozoa. And as other, more flexible and more efficient control devices have developed in higher forms, morphogenetic capacity has assumed a decreased importance in defense—consider the reduced regeneration potential of mammals, for example—but an increased importance as a mechanism for embryonic development, required only minimally in protozoa.

Finally, it is interesting to consider that every one of the morphogenetic response reactions in protozoa has been claimed, individually and repeatedly, to entail a "rejuvenescence" of the organism in question. Is rejuvenescence not merely a descriptive restatement of "morphogenesis"?

THE COURSE OF MORPHOGENESIS

The Pattern

The Normal Pattern

Morphogenesis in protozoa may be viewed as a triphasic event. An original initiating stimulus elicits a *preparatory* phase. It includes all processes connected with wound healing, with partial or complete dedifferentiation of surface structures, and with biochemical reactions in nuclei, endoplasm, and ectoplasm, through which the raw materials and building blocks are assembled for the second step. This is the *formative* phase, which may take place concurrently with, or may follow, the first, and which comprises the conversion of the building blocks into new, explicit

organelles. A *regulatory* phase usually ensues, characterized by the reproportioning of parts, by architectural shifts and adjustments, often by growth, in short, by all those processes which transform the "blastozoon" into a normal whole individual characteristic of the species.

The immediate stimulus necessary and sufficient to initiate ciliate morphogenesis may be identified. It consists of mechanical or physiological removal—by injury, excision, transection, solvation, or other interference with function—of specialized kinetosomes. Many different agencies can deliver this stimulus, and all agencies leading to regeneration, reorganization, or fission actually do. Why this specifically constitutes a necessary and sufficient stimulus will be discussed below, in the section on mechanisms. Here it may be emphasized that *only* such a change in kinetal environment will set in train morphogenetic events other than growth. Excise a minute part of the basal apparatus of oral structures, or injure a single basal granule of a hypotrich cirrus, and regeneration or reorganization will follow; but excise endoplasm, nuclear parts, or non-kinetal ectoplasm, and reorganization will not occur (though growth may). Transect a nonspecialized kinety, and very little happens; but transect a specialized kinety even temporarily, and morphogenetic reactions ensue at once (e.g., formation of supernumerary contractile vacuoles; Weisz, 1951a). It is quite likely that this initiating role of the cortex may prove to have parallels in cellular morphogenesis among metazoa.

What initiates fission? That the stimulus is endogenous, not exogenous as in regeneration and reorganization, and that it is experimentally not controllable so far, is certain. That it acts on, and through, the ectoplasm in precisely the same way as exogenous stimuli is also fairly certain: as already noted, developmental processes in the cortex appear to be the same for all forms of morphogenesis and, as Fauré-Fremiet (1948) and Lwoff (1950) particularly emphasized, cortical events *precede* all other events of fission (also v.i.). Statements occasionally found in the literature to the effect that *mitosis* "initiates" fission are clearly in error. Fission can occur in amicronucleate ciliates, and in normal fission mitosis is a very late step—if anything a result, not a cause, of cortical phenomena. (In this connection, Beers, 1946, found that mitosis is timed to occur during fission specifically, and that it is not independent of cell division, as some had previously claimed.)

The nature of the fundamental internal stimulus which acts on the ectoplasm and thereby initiates fission is still unknown. Preliminary data suggest tentatively that the macronucleus may be the original stimulating agency. In *Stentor*, Weisz (unpub.) found that if the physical continuity of the macronuclear chain was disrupted in prefission animals, fission was suppressed, i.e., primary cortical events, hence all subsequent ones also, would not occur. If this effect can be shown to be specific, then emission of a fission-initiating signal could be concluded to depend on the wholeness of the macronucleus. This in turn would suggest a functional involvement of the anteroposterior potential gradient in macronuclear nodes (v.s.), since this gradient—of maximal steepness in prefission animals—is probably the only condition likely to be affected when macronuclear continuity is interrupted. These observations, of course, are inconclusive. Clearly, any comprehensive hypothesis of fission-initiation would have to show (1) how the intrinsic temporal rhythm of successive fissions is controlled, i.e., how fission becomes a necessary consequence of the prior vegetative history of an animal; and (2) why mitosis and macronuclear and cytoplasmic cleavage would not occur in regeneration and reorganization, despite the fact that ectoplasmic stimulation here is the same as in fission.

After a sufficient morphogenesis-initiating stimulus has exercised its effect on the ectoplasm, all divisions of the protozoan body soon participate in the morphogenetic response. Concerning pertinent endoplasmic functions, precise and extensive studies are urgently needed. Only a few non-specific data are available so far, and they indicate generally that endoplasm mobilizes stored raw materials and other ingredients required in morphogenesis. In *Stentor* this is particularly noticeable when the environmental stimulus is abrupt, as in merotomy. During the more gradual preparation possible prior to fission, there is time for used reserves to be replaced. Hence utilization does not become as apparent (Weisz, 1949a).

Nuclear activities during the course of morphogenesis can be described in greater detail. If injury has entailed the loss of varying portions, macronuclei readily regrow to characteristic form, presumably by rapid multiplication of residual subnuclei. In many species, macronuclei reorganize during morphogenesis, i.e., they undergo karyokinetic cycles according to one of several

well-known patterns (e.g., condensation and reelongation, or skeining). Weisz (1951a) demonstrated a causal gearing between these nuclear movements and the events in the ectoplasm. In *Stentor*, nuclear contraction normally begins just after an adoral zone starts to differentiate from the kinetosomes in the "anarchic field" (v.i.). If this developing adoral zone is excised as soon as it appears, nuclear contraction never occurs; and if it is excised at a later stage, nuclear contraction stops at the moment of excision. This holds regardless of whether the process is regeneration, reorganization, or fission. Evidently, nuclear kinetics depend on direct stimuli from the ectoplasm.

[It may be noted, in this connection, that early adoral excisions in dividing stentors block not only nuclear movements but also all other phenomena of fission, i.e., mitosis, macronuclear division, and cytoplasmic constriction. It is known, also, that mitosis typically precedes macronuclear division and that the latter precedes cytoplasmic cleavage (e.g., Beers, 1946; Jones, 1951; Weisz, 1951a). But whether these events are elicited by independent direct stimuli from the ectoplasm, or whether one of these processes triggers the next, is still undetermined today.]

Weisz (1949c) suggested a possible functional significance of macronuclear condensation during morphogenesis. If nuclear chromatin at different body levels becomes functionally diverse during vegetative, pre-morphogenetic periods (as appears to be the case in *Stentor* and *Blepharisma*, v.s.), then condensation of all chromatin fractions into a single mass could have a pooling effect, and bring about an equalization of functional potentials throughout the pool. Subsequent redistribution of chromatin into a reelongating nucleus thus would establish an initial functional equality of all nuclear portions (as was found for *Stentor* and *Blepharisma*). Conceivably, skeining of normally compact nuclei could play an analogous reshuffling and equalizing role. Macronuclear kinesis in morphogenesis therefore might represent the equivalent of the "clearing of decks" in the ectoplasm, carried out there by surface dedifferentiation.

One feature of nuclear behavior has been recorded so frequently that it may well represent a standard activity during morphogenesis: the intensified emission into the cytoplasm of macronuclear products. This may take many forms; for example, "invisible" secretions necessary for shell repair in Foraminifera (e.g., Verworn, 1888; Rhumbler, 1902); noticeable extrusion droplets (e.g., MacLennan, 1937; Weisz, 1949a); extrusion of substantial chromatin elements, or resorption of whole sections of macronucleus by the cytoplasm (e.g., Calkins, 1930; Young, 1939; Beers, 1946). Calkins thought of these nuclear emissions as "purification" processes. Today, in line with hypotheses suggested by analogous extrusions in amphibian oocyte nuclei and in metazoan mitosis generally, it is perhaps justifiable to see in the macronuclear emissions some of the elusive gene derivatives of first, second, or lower order which unquestionably influence morphogenesis.

More than endoplasm or nuclear apparatus, it is the ectoplasm which defines the course of morphogenesis. This course follows different patterns in different groups of species (the following listing is adapted from Fauré-Fremiet, 1948).

1. The *Prorodon* pattern, one of several characteristic of holotrichs, and possibly the most primitive among ciliates (*Prorodon:* cf. Fauré-Fremiet, 1948b; *Didinium* and others by analogy). Longitudinal kineties, of presumably equal degree of specialization and, by analogy with *2* below, probably equipotentiality of kinetosomes within a kinety. Following merotomy at any antero-posterior level, or transection by a fission line, all kineties contribute to apical stomatogenesis in situ, by rapid reproduction of basal granules at kinetal terminals. Little or no dedifferentiation of existing structures during morphogenesis.

2. The *Stentor* pattern, characteristic of some holotrichs and some heterotrichs, and evolutionally probably closely related to *1*; very thoroughly analyzed (*Glaucoma:* Chatton and Lwoff, 1935; *Deltopylum:* Mugard, 1947; *Stentor:* Weisz, 1951a, c; *Blepharisma* and others by analogy). Longitudinal kineties, of which one or a few adjacent ventral ones are specifically specialized as stomatogenic kineties. The latter control the polarity of the organism, the longitudinal axis being determined with reference to the kinetal axis, not with reference to the protoplasmic bulk axis. They control the development and the maintenance of probably all surface organelles (including contractile vacuoles) except the general body ciliation. If the specialized kineties are excised, some of the others may, after a long interval, acquire the specialized functions. This points to a fundamental equipotentiality of all

kineties. Also, within a kinety, an equipotentiality of component kinetosomes can be demonstrated. Whenever specialized kineties are cut so that the cut ends cannot or do not fuse (e.g., merotomy, fission line), then kinetosomes at the cut ends become active morphogenetically. They reproduce rapidly, thus laying down an extrakinetal "anarchic field" (or "reorganization field"). This anlage later becomes rearranged into double rows of kinetosomes. When formed at anterior kinetal terminals, these kinetosomes differentiate into an adoral zone of membranelles and subsequently into a complete oral apparatus. "Anarchic" kinetosomes also mediate the development of holdfast organelles posteriorly, and of contractile vacuoles either anteriorly or posteriorly, depending on the species. Little or no dedifferentiation of existing structures in regeneration and fission. In reorganization, the old oral area (including gullet) dedifferentiates more or less completely, while a new set of oral organelles develops.

3. The *Bursaria* pattern, characteristic of some holotrichs and some heterotrichs, and probably related to *2* as *2* may be to *1* (*Bursaria:* cf. Fauré-Fremiet, 1948b; *Ophryoglena:* Mugard, 1947; *Folliculina:* Fauré-Fremiet, 1932; Villeneuve-Brachon, 1939; *Folliculinopsis:* Villeneuve-Brachon, 1939; others by analogy). Longitudinal kineties, of which a few ventral adjacent ones are specialized as in *2*. Kinetosomes within these stomatogenic kineties probably equipotential. Following adequate morphogenetic stimulation, more or less complete dedifferentiation of existing structures, with the exception of body cilia. This is a key difference over *2*. Subsequent development of one (as in regeneration and reorganization) or of two (as in fission) anarchic fields, at definite, predictable loci. Formative and regulatory phases as in *2*, although the migratory shifts of the adoral anlagen are more pronounced.

4. The *Euplotes* pattern, characteristic of hypotrichs generally; probably related to *3* as *3* may be to *2*; very thoroughly analyzed (*Euplotes:* Chatton and Seguela, 1940; by analogy also *Uronychia:* Calkins, 1911a; *Stylonychia:* Dembowska, 1925, 1926; *Oxytricha:* Reynolds, 1932; and others). Kinetosomal arrangement indicated by position of cirri and membranelles. Kinetosomes not equipotential. Following morphogenetic stimulation, total dedifferentiation of existing structures. Several groups of uniquely specialized kinetosomes produce several anarchic fields, either in single set (as in regeneration and reorganization), or in double set (as in fission). Following very extensive and complex migratory shifts to "correct" positions, each anarchic field differentiates specific surface organelles.

5. The *Vorticella* pattern, characteristic of peritrichs generally; studied very little to date. A direct derivation of this pattern from that of *1* is suggested on morphological and morphogenetic grounds (Balamuth, 1940; Chatton and Villeneuve, 1937). Transverse kineties, disposed in parallel rings. Longitudinal fission. In fission, no dedifferentiation of oral structures of parent; oral structures of embryo derived in situ, from the same anterior kineties which had given rise to the parental mouth apparatus. Chatton and Villeneuve call this "the most direct kind of genetic continuity known." While these features suggest a relationship with the primitive holotrich pattern (i.e., *1*), others are reminiscent of suctoria (*6*, below): the absence of body ciliation in the sessile adult, and the development of free-swimming embryos which, like accidentally or experimentally detached adults, carry a circlet of cilia near the posterior end (cf. Runyan and Torrey, 1914). Regeneration of individual zooids not yet studied.

6. The *Podophrya* pattern, characteristic of Suctoria generally (*Podophrya:* Chatton, Lwoff, and Tellier, 1929; Fauré-Fremiet, 1945). No body ciliation in the adult, but kinetosomes present in irregular distribution over the whole ectoplasm. Certain ones produce an anarchic field in a circumscribed locus. The component kinetosomes subsequently organize into a band of parallel kinetosomal rows (reminiscent of pattern *1*), cilia develop here, and this part of the animal is included in a bud which then constricts off as a free-swimming embryo. Upon attaining the sessile stage, the embryo resorbs its cilia, the kinetosomal rows become disorganized, and the infraciliary state typical of the adult emerges.

The above are by no means the only existing patterns. Others have been studied, particularly among parasitic ciliates (cf. the many beautiful analyses by the French protozoologists, e.g., Chatton and Lwoff, 1935, 1949, 1950; also Lwoff, 1950). And even among free-living ciliates many more patterns are certain to be discovered. But the categories described do include most of the usual laboratory ciliates. And even though this range is limited, certain evolutionary trends re-

garding the morphogenetic machinery are clearly discernible.

Prorodon appears to be close to the primitive proto-pattern, with at least three lines radiating from it: one via holotrichs and heterotrichs, culminating in the hypotrich pattern; another culminating in the peritrich pattern; and a third in the suctorian pattern. The independent derivation of Suctoria from primitive holotrichs (rather than from peritrichs) was suggested by Kahl (1931), and comparative morphogenesis corroborates this view. In both peritrichs and suctorians, lack of body ciliation in adults and reproduction by means of embryos represent secondary adaptations to sessilism, and are probably instances of convergent evolution. For an analysis of ancestral relationships, embryonic, not adult, homologies are important, and here peritrichs and suctoria reveal their independent origination from primitive types: as Lwoff (1950) emphasized particularly, the embryos of both groups feature the parallel rows of kinetosomes, and the direct differentiation of cortical organelles in situ, so characteristic of the *Prorodon* pattern.

In this connection, Lwoff made another significant observation. An antagonism between differentiation and division has often been demonstrated in metazoan embryology. In protozoa, such an antagonism might readily be considered not to exist, since in many cases the adult apparently divides even though it is differentiated. Lwoff pointed out, however, that what divides is not at all a differentiated adult, but a dedifferentiated organism, or one which has temporarily reverted to the evolutionally primitive state. He showed clearly that this reversion, prior to cleavage, to the primitive kinetosomal pattern of distant ancestors occurred even in the most highly evolved parasitic types. Events in Suctoria, for example, support the argument further. The implications are that if a ciliate is primitive to begin with, like *Prorodon*, morphogenesis can proceed directly, in situ. But the farther away an adult has evolved from this primitive kinetal pattern, the greater a structural upheaval is occasioned by the reversion to type during morphogenesis. The *Prorodon-Stentor-Bursaria-Euplotes* series of patterns illustrates this point rather well. Hence Lwoff considers the antagonism between differentiation and division to be real. An "adult" is considered to be unable to undergo division, and a pre-dividing ciliate, having assumed or already possessing evolutionally primitive features, is held to be roughly homologous to a metazoan egg. Indeed, this analogy might be carried one step further: the pre-dividing *Prorodon* type compares well with an indeterminate, regulative egg, and the pre-dividing *Euplotes* type, with a determinate, mosaic egg.

The Abnormal Pattern

Abnormal development in protozoa has been studied as long as normal development. After the earliest observations by Balbiani (1891, 1893) on *Paramecium* and *Stentor*, and by Johnson (1893) on *Stentor*, teratomatous conditions were investigated in a wide variety of ciliates: e.g., *Uronychia* (Calkins, 1911a); *Paramecium* (Calkins, 1911b; DeGaris, 1927); *Bursaria* (Lund, 1917); *Oxytricha* (Dawson, 1920); *Glaucoma* (Chatton, 1921); *Uroleptus* (Calkins, 1925); *Colpidium* (Chatton, 1925; Sonneborn, 1932); *Euplotes* (Kimball, 1941); *Stentor* (Weisz, 1951b; Tartar, 1941, 1953). Unquestionably the most extensive contribution to protozoan teratology was made by Fauré-Fremiet (1906, 1910, 1945, 1948a, b), who studied abnormal morphogenesis in *Stentor*, *Bursaria*, *Enchelys*, *Didinium*, *Leucophrys*, and in three species of *Urostyla* and two species of *Paramecium*.

The first abnormal individuals to be described included variously malformed single animals and di- and polystomic monsters, all found fortuitously in mass cultures. It was discovered early, however, that fused complexes of several animals could be produced at will, by interfering with the cleavage constriction during fission so that daughter individuals remained joined together. Several agents are now known to accomplish this: mechanical injury (Balbiani), bacterial injury (Chatton, Sonneborn), osmotic injury (Chatton), ultraviolet light (DeGaris), and dilute formalin (Fauré-Fremiet). By repeated interference with successive fissions, Balbiani was able to produce monsters composed of more than a dozen individuals, irregularly joined. Others, notably Fauré-Fremiet and Kimball, succeeded in producing orderly doublets, triplets, and quadruplets, the component members joined in patterned homopolar and heteropolar orientations. The most recent technical advance in producing controlled teratomatous conditions was introduced by Tartar (1941), who discovered that *Stentor* fragments could be grafted together. Using Tartar's method, Weisz (1951b) produced simple and complex fusion systems of whole animals, fragments, or both, joined in any desired manner and containing

any desired nuclear complements. Tartar (1953) recently succeeded in producing graft combinations with varying nuclear complements between two different species of stentor, *S. coeruleus* and *S. polymorphus*, an important advance in technique that should yield many valuable data.

Today, all "spontaneous" teratomata found in cultures can be duplicated experimentally, and the principles of their formation, as well as their subsequent history, are understood fairly well. Moreover, teratology has already contributed significantly to an understanding of the morphogenetic mechanism.

Abnormal, like normal, morphogenesis is preeminently a story of kineties and kinetosomes. As has been noted above, when a specialized kinety is cut or otherwise bisected so that the cut terminals do not fuse, then the terminals become morphogenetically active. This is the first event in normal morphogenesis, and also in monster formation. In non-dividing animals, a bisected kinety ordinarily fuses together again within seconds, without further consequences. But if the cut terminals are twisted out of position so that the separation becomes permanent, then a monster will form. The posterior end of the anterior kinetal segment produces a second set of posterior organelles (e.g., a holdfast), and the anterior end of the posterior segment gives rise to a second set of oral structures. Similarly, if a specialized kinety is permanently cut into several segments, a corresponding number of supernumerary organelles forms. In dividing animals, the fission line brings about a (physiological) kinetal sectioning, and normally this is followed by the complete separation of two fully formed morphologies. But if the fission line is partly or wholly excised, or if it is twisted out of position somewhere along its course, then a monster will form: a double morphology develops; but cleavage constriction along the abnormal fission line is bound to be abortive, or cannot occur at all, daughters consequently do not separate, and a distomic doublet emerges. When either or both members of this doublet are again mutilated just before the next fissions are to take place, a triplet or quadruplet is produced; and so on for polystomic complexes of higher order.

It will be noted that these principles of formation make clear why a wide variety of non-specific agents can produce teratomata; and they also provide the link differentiating normal from abnormal morphogenesis. If damage to the infraciliary system is *not* accompanied by surface disfiguration or disorientation, then normal morphogenesis ensues. But if surface distortion is involved in addition, then teratomata develop.

What is the history and fate of a teratomatous condition? It possesses, at best, a temporary stability: either it leads to the death of the organism, or it elicits reorganization, through which normal individuals are reformed. The literature reveals the following specific patterns:

1. Malformed single individuals generally reorganize or regenerate into normal animals (Balbiani, Johnson, Fauré-Fremiet, Weisz). Supernumerary organelles are resorbed (but if an original organelle is excised, the corresponding supernumerary one becomes a permanent replacement; see Weisz, 1951b). Faulty kinetal alignments heal in situ, i.e., a terminal of a specialized kinety eventually fuses with an apposed terminal of another kinety (whether specialized or not). This fusion probably brings about the cessation of morphogenetic activity at what had been a specialized terminal, hence dedifferentiation of the supernumerary structure would follow. Distorted but healed kinetal regions persist as surface scars through many division cycles.

2. Heteropolar doublets (parabiotic or telobiotic) may (a) twist into homopolar orientations (e.g., *Urostyla weissei*); or (b) separate into normal single individuals, in a process reminiscent of fissional cleavage (e.g., *Stentor*, *Bursaria*); or (c) give rise, by repeated fissions, to irregular polystomic complexes (e.g., *Didinium*, *Enchelys*).

3. Homopolar doublets (a) may reorganize into normal single individuals, either by incorporation of the smaller member and dedifferentiation of its organelles (e.g., *Stentor*), or by total dedifferentiation of the whole doublet and redifferentiation of a single morphology (e.g., *Bursaria*); (b) may separate into single animals (e.g., *Euplotes*, *Urostyla weissei*); (c) may remain a fairly stable doublet and produce, by fission, either two daughter doublets, or a regular quadruplet, or a regular triplet and a single animal (e.g., *Euplotes*, *Urostyla weissei*); (d) may, by repeated fissions, give rise to irregular polystomic complexes (*Didinium*, *Enchelys*); or (e) may eventually die, as in the extremely interesting and challenging case of situs inversus in *Urostyla trichogaster*. Here the inverted mirror-image-like member behaves like a non-feeding parasite as long as the complex lives. Detached from the doublet, the inverted member never feeds, nor divides, and soon dies.

(To pose only the most obvious question, why are the inverted mouth parts non-operational?)

4. Regular polystomes, directly produced or resulting secondarily from other patterns, usually reorganize into normal animals, or into associations as in *2*, *3*, or *5*. Quadruplets as in *3* may separate into two doublets; triplets may twist into irregular chains; regular polyaxial radiate complexes (e.g., *Stentor*) eventually separate and form normal animals.

5. Irregular polystomes, directly produced or resulting secondarily from other patterns, are invariably non-viable, unless their architecture permits easy rearrangement into regular ones (as sometimes happens in *Stentor*, for example). Before death supervenes, normal single daughter animals, or larger subcomplexes, may occasionally fission off from the main polystomic mass, provided a normal fission line can form near the base of a protruding portion of protoplasm (e.g., *Paramecium*, *Colpidium*, *Stentor*).

Three implications of these data are significant from the standpoint of morphogenetic theory. First, teratology provides another body of evidence that ciliate morphology, and even viability, depend on the normal, orderly disposition of the kinetal apparatus. Irregular non-reorganizable polystomes succumb not because of nuclear or endoplasmic malfunction or incompatibility—nuclei as well as endoplasm are interchangeable among the members of a complex without ill effects (cf. Weisz, 1951b), and Tartar's (1953) interspecies grafts prove this point even more dramatically. Rather, irregular polystomes succumb because in the process of their formation the patterned individuality of the infraciliature of each member has been disrupted or abolished altogether. Since such individuality can neither form de novo, nor redifferentiate from earlier residua (because of mechanical and architectural obstacles inherent in the irregular organization), death must be the eventual outcome.

Second, teratology strikingly reveals the functional polarity of kineties that is implied by their structure. Of all unstable polystomes, heteropolar ones are the most unstable. In a heteropolar doublet of *Stentor* or *Bursaria*, for example, a pulling apart of the members eventually occurs (v.s.). Here the kinetal terminals of one member have never fused with those of the other (which leaves all of them morphogenetically active), and the doublet has been held together temporarily by the mechanical cohesion of the endoplasms alone. The pulling apart involves progressive cytoplasmic constriction along the line of kinetal appositions, just as in fission. But why the pulling apart to begin with—why not kinetal fusion? There certainly is no fission line to prevent this. There exists, however, an incompatible polarity. It follows from the rule of desmodexy (v.s.) that in a heteropolar doublet the kinetosomal rows of one member are apposed, not to the kinetosomal rows of the other member, but to its kinetodesmas. That it is specifically this arrangement which prevents kinetal fusion is clearly shown when a heteropolar doublet is transformed experimentally into a homopolar one. Then the kineties are oriented in the same sense and direction, kinetal fusion occurs, and a pulling apart does not take place (cf. Weisz, 1951b).

It is almost certain that these observations bear importantly on normal fission. A fission line does not per se "effect" cleavage; it merely bisects kineties and prevents them from fusing. Physical separation of the daughters is accomplished as in the pulling apart of heteropolar members, above. This may be largely a surface tension phenomenon, as when the surface film of a droplet of mercury is broken.

There are other instances where kinetal incompatibility is revealed, e.g., in irregular polystomes of *Enchelys* and *Didinium*. In these, heteropolar kineties again do not fuse, despite the considerable growth pressure which pushes them together. Continuing growth in length merely deflects apposed kineties from their course, like two colliding trains twisted from their tracks. These various examples thus clearly demonstrate a transverse as well as a longitudinal polarity of kineties, and as has been noted, this lies at the root of the polarity of the normal organism.

Third, teratology contributes importantly to an elucidation of hierarchial "dominance" relationships which can be shown to exist among kinetosomes (cf. Weisz, 1951b). In a normal animal, the presence of oral kinetosomes inhibits the morphogenetic activity of specialized kinetosomes: if oral kinetosomes are excised or are rendered physiologically less efficient, then specialized kinetosomes become active at once (v.s.). Analogously, terminal kinetosomes inhibit non-terminal ones; specialized kinetosomes inhibit non-specialized ones. Also, oral kinetosomes inhibit supernumerary oral ones, if these should arise teratomatously; kinetosomes of a larger organelle inhibit those of a corresponding smaller one, as in a homopolar doublet; etc. The

possible nature of this dominance will be discussed below. Whatever its nature, it probably exercises an important function: its very existence may impose limiting conditions and balances which would prevent morphogenesis from "going wild" in the normal animal.

The Mechanism

The study of conditions and patterns, carried out during the preceding decades, has already revealed much of the mechanism of morphogenesis. The present possibility of producing, at will, an oral apparatus anywhere on the surface of a ciliate; of producing, at any desired surface point, oral, pedal, or any other organelles; of producing any (small) number of a stated type of organelle within a single ciliate; of producing a new polarity; or an anomalous proportionality of parts (by trimming anarchic fields experimentally); and of initiating, at will, any type of morphogenetic event except fission, or of halting a developmental process at virtually any stage; in short, of being able, by experimental means, to force the morphogenetic potential of protozoan protoplasm into a variety of preselected channels, with predictable results—these present capacities of the protozoologist unquestionably testify to a considerable understanding of morphogenetic mechanism.

Yet the crux of mechanism is still to be discovered. Any of the above abilities proves insight merely into a small, isolated segment of the morphogenetic process; and the individual segments are still to be joined in proper timing and sequence. From beginning to end, morphogenesis is a grand sweep of events, eminently self-directive, eminently self-limiting—a servomechanism of exquisite complexity. Can it yet be shown how, necessarily and sufficiently, one step elicits the next; or through what feedbacks the second step limits the first? Consider also the relationship of morphogenesis to "morphostasis" (Weisz, 1951c), the steady-state condition which prior morphogenesis has given rise to, and which succeeding morphogenesis will reestablish: what exactly changes when kinetosomes are injured and morphostasis gives way to morphogenesis? Or when the latter, completed, again is followed by morphostasis? These are among the crucial questions that cut to the core of mechanism; and a study of mechanism must eventually answer them. Today the answers are but hypotheses and frank speculation, fortified here and there by bits of concrete evidence. Yet, there is sufficient promise in even these answers to mark out definite directions for future research.

The starting point in any discussion of morphogenetic mechanism must be the elementary observation that living organization has never disappeared entirely since it has first arisen. A ciliate, for example, may have been injured, mutilated, divided, or otherwise altered, but a representative, diagnostic sample has always persisted. If the last sample were destroyed also, then the organization would be lost irretrievably, since it cannot form de novo. Given a minimum sample, however, then morphogenesis can restore wholeness. Morphogenesis therefore is to be looked upon as a process of *completion* and *elaboration*, rather than one of genesis out of the void. (Obviously this makes the problem of analysis somewhat easier.) Furthermore, since morphogenesis is species-specific and even organism-specific, it follows that the preexisting sample organization profoundly influences, and guides, the completion process. Hence an analysis of morphogenetic mechanisms properly begins with the question: "What must be left for a new start?" and then proceeds to the question: "What property of such a minimum remnant furnishes the guiding channels which orient the completion process?"

No amount of nuclear activity, per se, can create a protozoan cortex (including kinetosomes), and no amount of cortical activity, per se, can create nuclear material. A half-century of experimentation has demonstrated this conclusively. Cortex and nucleus must therefore be represented in any minimum sample of protozoan—and, indeed, general cellular—morphology. It is uncertain whether, singly or together, cortex and nucleus can create endoplasm, and to be safe one may tentatively assume endoplasm to be also included in a minimum sample. Two important consequences follow at once from this relative autonomy of cortex and nucleus. Since neither one can create the other, *they must be independent morphogenetically*. But since both are essential for viability, *they must cooperate physiologically*, in reciprocal, cyclical fashion, but on a non-morphogenetic level.

The implications are clear. The statement "genes control morphogenesis" means only that genes control the *functioning* of the (preexisting) developmental apparatus of the cortex; it does *not* mean that genes control the organization of that apparatus, nor that they control the pattern, or the course, of cortical development. These must be self-controlled within the cortex. Analogously,

the cortex cannot control the morphogenesis of the nucleus, i.e., the structure, developmental patterns, and evolution of genes; but it *can*, and does, influence the *functioning* of existing genes. Two lines of inquiry thus emerge. (1) How does the cortex regulate its own morphology? (The correlate, "how do genes regulate their own morphology?" is best left to be discussed several decades hence.) (2) What is the nature of the reciprocal physiological interaction between cortex and nucleus?

Concerning the first of these questions, two hypotheses (Lwoff, 1950; Weisz, 1951c) are on record, both relating to ciliates. Both start off with the observation that the ciliate cortex is regionally diverse, and both postulate that kinetosomes are variously differentiated, in accordance with particular conditions existing at local microenvironments. Differentiated kinetosomes are postulated to act back on the cortical environments, thus perpetuating local conditions. Both Lwoff and Weisz envisage an intimate cyclical interaction of this kind, Lwoff stressing its physical and Weisz its chemical aspects.

Lwoff's hypothesis conceives electronic or intermolecular forces operating between kinetosomes and the argyrophilic cortical network of ciliates. Kinetosomes are suggested to be held in place at the meshes of the net. The mutual electronic binding forces would thereby be saturated, and this bonding would produce the spatial orientation, and the functional fixation, of the kinetosomes. The argyrophilic net is known to be able to grow, but only to a species-limited extent. At maximum expansion, it is believed to form a relatively rigid framework. While the net is still capable of growth, as in young, post-fissional animals, newly produced kinetosomes (possessing free bonding forces) would manufacture more meshes around themselves from endoplasmic substrates, and so would build on to the net. If the meshwork has already reached full growth, as before fission, newly produced kinetosomes neither could attach to the already saturated net, nor could extend it, and thus would form extra-kinetal anarchic fields. Their free bonding forces would now initiate morphogenesis, i.e., the construction of new kinetosome–cortical-net complexes.

In its broad scope, and without rigorous inquiry into details of mechanism, this is an ingenious and valuable hypothesis. It is probably the first to assign a function, other than that of passive support, to the argyrophilic net. Moreover, the hypothesis suggests a physical mechanism which would orient kinetosomes spatially, and such a mechanism is required in any kinetosomal theory of morphogenesis. Problems of regeneration and reorganization are not explicitly accounted for, but they could readily be fitted into the scheme. What is not shown is how electronic limiting conditions, per se, would produce functional differentiations of kinetosomes. For this, some sort of chemical framework must be postulated, and here Weisz's hypothesis may be pertinent.

Where Lwoff's morphogenetic "constraining" device is physical, Weisz's is metabolic. Variously differentiated kinetosomes (hence various cortical loci) are postulated to remain in given functional channels by virtue of being organized into a competitive metabolic hierarchy. The existence of such an hierarchy is suggested by the hierarchical dominance relationships among kinetosomes, as demonstrated in regeneration and abnormal morphogenesis (v.s.). Once a class of kinetosomes is differentiated in a certain way, it would fill a specific metabolic niche. Each class of kinetosomes would fill its unique niche, and would, under normal conditions, be competitively able to withdraw from the endoplasmic pool exactly those raw materials which would permit it to maintain its state of differentiation. Competition would be greatest for materials required to maintain the most complex states of differentiation, e.g., those of the oral area. Not only would such metabolic stratification reinforce regional cortical characteristics, but it would also provide limiting barriers against changes in kinetosomal differentiation. If new kinetosomes are formed locally, their differentiation would be channeled "correctly" by these barriers—hence morphostasis. A sufficient stimulus for morphogenesis would be any change which reduces the competitive effectiveness of a class of kinetosomes. Thus transection or injury at the oral area, or physiological isolation prior to fission, would render oral kinetosomes functionally less efficient, or would remove them bodily or physiologically. This in effect would vacate the metabolic niche originally held by oral kinetosomes. Unused raw materials specific for that niche would now be available, which kinetosomes next lower in the hierarchy could utilize. Such "lower" kinetosomes would therefore be enabled to reproduce rapidly, and they would lay down an anarchic field. Resynthesis of the inefficient, isolated, or lost parts could now ensue. The course of this resynthesis would be held in "proper"

channels by the nature of the specific raw materials available, i.e., by the metabolic barrier imposed by the rest of the hierarchy. Thus the anarchic kinetosomes would gradually differentiate, thereby reoccupying the free metabolic niche. Once this is achieved, unclaimed metabolites would no longer exist, and additional anarchic kinetosomes could therefore no longer form. Hence morphogenesis would come to a halt, and a morphostatic status quo would have been reattained.

This hypothesis has the advantage of suggesting an autonomous, self-regulative mechanism which describes morphostasis and morphogenesis as a unified, causal sequence of events. The hypothesis lacks a physical scheme which would orient kinetosomes spatially, and that is precisely what Lwoff's concept supplies. The two views are clearly complementary.

How and where does the nuclear apparatus fit into such a pattern? As has been noted above, the autonomy of cortex and nucleus suggests a non-morphogenetic, reciprocal interaction between these two structures. Evidence for such interaction has in part already been cited in earlier contexts. In one direction, nuclei demonstrably emit substances, and at an increased rate during morphogenesis; and kinetosomes have been shown to be non-functional unless active nuclei are present. In the reverse direction, kinetosomes demonstrably influence nuclear kinesis. Moreover, several lines of evidence indicate that the cytosome in general and the cortex in particular may also influence the nuclear apparatus with respect to function. Thus Sonneborn (1947, 1951) has discovered various instances of cytoplasmic control over nuclear activity, including for example the ability of the cytoplasm to determine which of several possible mating types a newly formed macronucleus will control. Further, Nanney (1953b), working on *Tetrahymena*, concluded: "... it is clear that the cytoplasm plays a critical role in directing the activities of the nuclei.... Experimental alterations in the positions of the nuclei result in alterations in nuclear behavior...." This observation is rather parallel to that of Weisz (1951c, also v.s.) that, in *Blepharisma* and *Stentor*, a correlation exists between "on the one hand, maintenance of nuclear function and proximity of highly specialized kinetosomes, and on the other, decline of nuclear function and absence of specialized kinetosomes from the immediate vicinity...."

Much more evidence along such lines will unquestionably have to be adduced, but even the few data now available strongly point to cytoplasmic and cortical control over nuclear function. The record suggests, moreover, that when nuclear units are dispersed spatially, then a regional divergence of explicit nuclear activity may result, in a pattern reflecting the regional diversity of cortical and cytosomal functions. Weisz (1951c) pointed out a conceivable parallel in metazoa, where cortical functions also differ from cell type to cell type, and where genomes are also dispersed spatially throughout the organism.

How would cortex and nucleus interact? As indicated above, one would search in vain for substances or agents through which either cortex or nucleus "controls" morphogenesis in the other, in the sense of an architect or building contractor controlling the erection of a house. Each of the two body divisions contains its own "built-in" machinery for local morphogenesis, and the preceding hypotheses on cortical function have suggested how such machinery might operate, in autonomous, self-controlled manner. But an appropriate machinery per se is not sufficient: its operation requires raw materials, and means to utilize these raw materials. Thus, in line with current views on gene function, the nuclear apparatus of protozoa may be envisaged as a catalyst supplier. For ciliates, enzymatic nuclear derivatives would permit proper substrate utilization on the part of kinetosomes, and enzymatic kinetosomal derivatives in turn would permit substrate utilization on the part of genes.

One phase of this view has received some support by recent biochemical work on amebae. By comparing nucleated and enucleated merozoa, it was shown (1) that the amount of RNA-protein slowly decreased in enucleated fragments, a change indicating nuclear control of synthesis in the normal animal (Brachet, 1950); (2) that P_{32} uptake was strictly dependent on the presence of the nucleus, a relation indicating nuclear control of phosphorylating mechanisms in the normal animal (Mazia and Hirshfield, 1950); and (3) that oxygen uptake remained normal in enucleated fragments, for substantial periods of time, a relation indicating cytoplasmic rather than nuclear control of oxidative reactions (Brachet, 1951a, b). Brachet concluded that the nucleus normally may play a part in the coupling between oxidations and

phosphorylations, thereby exercising control over syntheses in the cytoplasm. That such control would have to involve nucleus-derived catalysts can hardly be doubted.

Thus in broad, general terms, the mechanism of morphostasis and morphogenesis in ciliates might be visualized as follows. With adequate nutrition, the nuclear apparatus emits specific enzymatic agents into the endoplasm. Variously differentiated kinetosomes utilize these agents selectively, together with nutritive raw materials, toward maintenance of their function: they maintain surface organelles; they interact cyclically with the local microenvironment, including the argyrophilic net, thus aiding in perpetuating the regional diversity of the ectoplasm; and they produce specific enzymatic agents which act back on the nuclear apparatus, controlling its kinesis and its metabolic activity. This circumscribes the morphostatic condition. Interference with the functioning of particular kinetosomes results in a disruption of the local kinetosome–microenvironment or the kinetosome–nucleus cycle of interaction. This vacates at least one, and often several, levels in the metabolic hierarchy among kinetosomes, and it disrupts the patterned orienting forces between kinetosomes and the argyrophilic net. With the residual hierarchy and net as modeling patterns and channeling agencies, the whole hierarchy and the whole net are then reestablished: newly produced kinetosomes gradually fill in the available metabolic levels and bind a new meshwork around themselves, differentiating "correctly" in the process. New-formations stop automatically once a status quo is reconstituted (v.s.). This circumscribes the morphogenetic condition.

The scheme pulls together such experimental evidence and speculation as is available today, and it provides a connected framework within which the evidence can be broadly explained. In one major respect all of the above is silent, and no plausible interpretation is as yet in sight: what is the causal, sequential mechanism of form-regulating shifts and movements, in endoplasm, nucleus, and ectoplasm, that accompanies every morphogenetic event? An elucidation of this, and the procurement of precise data which would either flesh out and substantiate, or modify and contradict, the mechanism outlined above—these represent the main directions in which future research is likely to move.

CONCLUSION

Not all protozoa possess kinetosomes. It may well be wondered whether analyses for ciliates can have general applicability to protozoa as a whole. Probably yes. While many protozoa are not equipped with kinetosomes, all are equipped with an ectoplasmic cortex—and it is primarily this cortex, with its explicit morphology, that differentiates one protozoon from another. Each cortical locus undoubtedly possesses specific diagnostic elements on the molecular level. This must be true for any protozoon and, indeed, for any metazoan cell as well. What is different from species to species or cell-type to cell-type is the arrangement in which these diagnostic elements are organized. In some groups, cortical components occur in dispersed "molecular ecologies," usually not demonstrable cytologically. In others, they occur partly in dispersed dispositions, as above, partly in polymolecular aggregations recognizable as "kinetosomes" or as other formed organites. Molecular *structuring* within the cortex varies. But molecular *functioning* may well follow the same overall pattern, alike in all protozoa and metazoan cells, eggs included: cyclical, self-directing and self-limiting interaction among components within the cortex, and cyclical interaction between cortex and nucleus. To the extent that a study of kinetosome-possessing protozoa aids in elucidating these relationships, it also aids in gaining insight into cellular morphogenesis among metazoa.

The cortical mechanism generally and the kinetosomal mechanism specifically unquestionably were among the earliest systems of morphogenesis to evolve. Kinetosomes may be traced back at least as far as the first protistan unicells which developed flagellary locomotion. From these organisms the infraciliary apparatus presumably passed into the plant kingdom via other algae, and into the animal kingdom via other protozoa. Kinetosomes are still present in most algal classes, where they are of vital importance in spore dispersal and gamete locomotion; and in all protozoan classes, ciliates being the group in which they attained fullest flower. Transmitted by both plant and animal groups to their evolutionary descendants, the kinetosomal mechanism still proves its significance today in the ciliated sperms of mosses and ferns, and very abundantly in all

animals: the propulsion device of sperms, the varied ciliary equipment of epithelia and of sensory cells, and above all, the centriole ("blepharoplast," "kinetoplast") involved in every mitosis and meiosis. Metazoa and metaphyta have developed other morphogenetic mechanisms, principally on the tissue level (e.g., induction). Yet on the cellular level, the ancient kinetosomal mechanism, and the probably even more ancient cortical mechanism in general, still fill a vital, indispensable niche.

LIST OF LITERATURE

ALFERT, M. 1952. Studies on basophilia of nucleic acids: the methyl green stainability of nucleic acids. *Biol. Bull.*, 103: 145–156.

BALAMUTH, W. 1940. Regeneration in protozoa: a problem of morphogenesis. *Quart. Rev. Biol.*, 290–337.

——. 1942. Studies on the organization of ciliate II. Reorganization processes in *Licnophora macfarlandi* during biniary fission and regeneration. *J. exp. Zool.*, 91: 15–43.

BALBIANI, E. G. 1888. Recherches expérimentales sur la mérotomie chez les Infusoires ciliés. Contribution a l'étude du rôle physiologique du noyau cellulaire. *Rec. zool. suisse*, 5: 1–72.

——. 1891a. Sur les régénerations successives du peristome comme caractère d'âge chez les Stentors et sur le rôle du noyau dans ce phenomène. *Zool. Anz.*, 14: 312–316.

——. 1891b. Sur la formation des monstres doubles chez les Infusoires. *J. Anat., Paris*, 27: 169–196.

——. 1892. Nouvelles recherches expérimentales sur la mérotomie des Infusoires ciliés I. *Ann. Micrograph.*, 4: 369–407; 449–489.

——. 1893. Ibid. II. *Ann. Micrograph.*, 5: 1–25; 49–84; 113–137.

——. 1899. Études sur l'action des sels sur les Infusoires. *Arch. Anat. micr.*, 2: 518–600.

BAUER, E. S., and A. M. GRANOWSKAJA. 1934a. Die Rekonstruktion des Kerns und die Atmungsprozesse bei Hypotricha im Ergebnis operativer Einwirkungen auf das Protoplasma und ihre Abhängigkeit vom Alter. *Biol. Zh.*, 3: 457–464.

——, and ——. 1934b. Abhängigkeit der experimentellen "individuellen Unsterblichkeit" vom Alter. *Biol. Zh.*, 3: 609–618.

BEERS, C. D. 1946. History of the nuclei of *Tillina magna* during division and encystment. *J. Morph.*, 78: 181–200.

BRACHET, J. 1950. Une étude cytochimique des fragments nuclées et énuclées d'amibes. *Experientia*, 6: 294.

——. 1951a. Oxygen uptake of nucleated and non-nucleated halves of *Ameba proteus*. *Nature, Lond.*, 168: 205.

——. 1951b. Quelques effets cytologiques et cytochimiques des inhibiteurs des phosphorylations oxydatives. *Experientia*, 7: 344.

BRANDT, K. 1877. Über *Actinosphaerium eichhornii*. Dissertation Halle, pp. 1–54.

BURNSIDE, L. 1929. Relation of body size to nuclear size in *Stentor coeruleus*. *J. exp. Zool.*, 54: 473–483.

CALKINS, G. N. 1911a. Regeneration and cell division in *Uronychia*. *J. exp. Zool.*, 10: 95–116.

——. 1911b. Effects produced by cutting *Paramecium* cells. *Biol. Bull.*, 21: 36–72.

——. 1925. *Uroleptus mobilis*. V. The history of a double organism. *J. exp. Zool.*, 41: 91.

——. 1930. *Uroleptus halseyi* Calkins. II. The origin and fate of the macronuclear chromatin. *Arch. Protistenk.*, 69: 151–174.

CAUSIN, M. 1931. La régénération du *Stentor coeruleus*. *Arch. Anat. micr.*, 27: 107–125.

CHATTON, E. 1921. Réversion de la scission chez les Ciliés. Réalisation d'individus distomes et polyénergides de *Glaucoma scintillans*, se multipliant indefiniment par acissiparité. *C. R. Acad. Sci., Paris*, 173: 393.

——. 1925. L'action des facteurs externes sur les Infusoires. Le déterminisme de la formation des chaines chez les *Colpidium*. *C. R. Acad. Sci., Paris*, 180: 1225.

——, and A. LWOFF. 1935a. Les ciliés apostomes. I. Aperçu histoirque et général; étude monographique des genres et des espèces. *Arch. Zool. exp. gén.*, 77: 1–453.

——, and ——. 1935b. La constitution primitive de la strie ciliaire des Infusoires. La desmodexie. *C. R. Soc. Biol., Paris*, 118: 1068–1072.

——, and ——. 1949. Recherches sur les Ciliés Thigmotriches. I. *Arch. Zool. exp. gén.*, 86: 169–253.

——, and ——. 1950. Ibid. II. *Arch. Zool. exp. gén.*, 86: 393–485.

——, and ——. 1936. Les remaniements et la continuité du cinetome au cours de la scission chez les Thigmotriches Ancistrumides. *Arch. Zool. exp. gén.*, 78: 84–91.

——, ——, M. LWOFF, and J. MONOD. 1931. La formation de l'ébauche buccale postérieure chez les Ciliés en division et ses relations de continuité avec la bouche antériéure. *C. R. Soc. Biol., Paris*, 107: 540–544.

——, ——, ——, and L. TELLIER. 1929. L'infraciliature et la continuité génétique des blépharoplastes chez l'Acinetien *Podophrya fixa*. *C. R. Soc. Biol., Paris*, 100: 1191–1196.

——, and J. SEGUELA. 1940. La continuité génétique

des formations ciliaries chez les Ciliés hypotriches. Le cinetome et l'argyrome au cours de la division. *Bull. biol.*, 74: 349–442.

——, and S. Villeneuve. 1937. La division de la bouche et la formation du peristome chez les Peritriches. Leur continuité génétique immédiate. *C. R. Acad. Sci., Paris*, 204: 538–541.

Chejfec, M. 1932. Regulation und Regeneration von *Paramecium caudatum*. *Acta Biol. Gen.*, 7: 115–134.

Chen, T. T. 1940. Polyploidy and its origin in *Paramecium*. *J. Hered.*, 31: 175–184.

Cienkowski, L. 1873. Über *Noctiluca miliaris* Sur. *Arch. mikr. Anat.*, 9: 47–61.

Claparède, E., and J. Lachman. 1858. Études sur les Infusoires et les Rhizopodes. *Mém. Inst. nat. génév.*, 5, 6: 1–482; 7: 1–291.

Dass, C. M. S. 1953. Studies on the nuclear apparatus of peritrichous ciliates. *Proc. nat. Inst. Sci. India*, 19: 389–404.

Dawson, J. A. 1920. An experimental study of an amicronucleate *Oxytricha*. II. The formation of double animals or "twins". *J. exp. Zool.*, 30: 129.

DeGaris, C. F. 1927. A genetic study of *Paramecium caudatum* in pure lines through an interval of experimentally induced monster formation. *J. exp. Zool.*, 49: 133.

Dembowska, W. 1925. Studien über die Regeneration von *Stylonychia mytilus*. *Arch. Entwmech. Org.*, 104: 185–209.

——. 1926. Studies on the regeneration of protozoa. II. Regeneration of the ciliary apparatus in some marine Hypotricha. *J. exp. Zool.*, 43: 485–504.

——. 1938. Körperreorganisation von *Stylonychia mytilus* beim Hungern. *Arch. Protistenk.*, 91: 89–105.

Dembowski, J. 1913. Versuche über die Merotomie der Gregarinen. *Arch. Protistenk.*, 29: 1–21.

Dujardin, F. 1841. *Histoire Naturelle des Zoophytes. Infusoires*. Fain & Thunot, Paris.

Ehrenberg, C. G. 1838. *Die Infusionstierchen als vollkommene Organismen*. Voss, Leipzig.

Ellis, J. 1769. Observations on a particular manner of increase in the animalcula of vegetable infusions. *Phil. Trans.*, 59: 138–152.

Fauré-Fremiet, E. 1906. Sur un cas de monstruosité chez *Stentor coeruleus*. *Arch. Anat. micr.*, 8: 660.

——. 1910. La division de *l'Urostyla grandis*. *Bull. sci. Fr. Belg.*, 44: 215.

——. 1932. Division et morphogénèse chez *Folliculina ampulla*. *Biol. Bull.*, 66: 77–110.

——. 1943. Le probleme de l'organisation et ses aspects physicochimiques. *Rev. sci., Paris*, 81: 433.

——. 1945a. Duplicité homopolaire et symetrie chez les *Urostyla*. *C. R. Soc. Biol., Paris*, 139: 637.

——. 1945b. Symetrie et polarité chez les Ciliés bi- ou multicomposites. *Bull. biol.*, 79: 106–150.

——. 1948a. Doublets homopolaires et régulation morphogénetique chez le cilié *Leucophrys patula*. *Arch. Anat. micr. Morph. exp.*, 37: 183–203.

——. 1948b. Les mécanismes de la morphogénèse chez les ciliés. *Folia biotheor. Leiden*, 3: 25–58.

Gelei, J. von. 1935. Der Richtungsmeridian und die Neubildung des Mundes während und ausserhalb der Teilung bei den Ziliaten. *Biol. Zbl.*, 55: 436–445.

Greeff, R. 1867. Über *Actinophrys eichhornii* und einen neuen Süsswasserrhizopoden, besonders in Rücksicht auf Theilbarkeit derselben resp. Vermehrung durch künstliche Theilung. *Arch. mikr. Anat.*, 3: 396–403.

Gruber, A. 1885. Über künstliche teilung bei Infusorien. *Biol. Zbl.*, 4: 717–722; 5: 137–141.

——. 1886. Beiträge zur Kenntnis der Physiologie und Biologie der Protozoen. *Ber. naturf. Ges. Freiburg i. B.*, 1: 33–56.

Hegner, R. W. 1920. The relations between nuclear number, chromatin mass, cytoplasmic mass, and shell characteristics in four species of the genus *Arcella*. *J. exp. Zool.*, 30: 1–95.

Hertwig, R. 1903. Über Korrelation von Zell- und Kerngrosse und ihre Bedeutung fur die geschlechtliche Differenzierung und die Teilung der Zelle. *Biol. Zbl.*, 23: 49–62; 108–119.

——. 1908. Über neue Probleme der Zellenlehre. *Arch. Zellforsch.*, 1: 1–33.

Hetherington, A. 1932. On the absence of physiological regeneration in *Stentor coeruleus*. *Arch. Protistenk.*, 77: 58–63.

Hosoi, T. 1937. Protoplasmic streaming in isolated pieces of *Paramedium*. *J. Fac. Sci. Tokyo Univ.*, Zool., 4: 299–305.

Ishikawa, H. 1912. Wundheilungs- und Regenerationsvorgänge bei Infusorien. *Arch. EntwMech. Org.*, 35: 1–29.

Jennings, H. S. 1908. Heredity, variation and evolution in Protozoa. I. *J. exp. Zool.*, 5: 577–632.

Joff, N. A. 1923. Über Regeneration bei Infusorien. *Arch. Tusses Protist.*, 2: 220–229.

Johnson, H. P. 1893. A contribution to the morphology and biology of the Stentors. *J. Morph.*, 8: 467–562.

Jones, E. E. 1951. Encystment, excystment, and the nuclear cycle in the ciliate *Dileptus anser*. *J. Elisha Mitchell sci. Soc.*, 67: 205–217.

Kahl, A. 1931 Über die verwandtschaftlichen Beziehungen der Suktorien zu den prostomen Infusorien. *Arch. Protistenk.*, 73.

Kimball, R. F. 1941. Double animals and amicronucleate animals in *Euplotes patella*, with particular reference to their conjugation. *J. exp. Zool.*, 86: 1–32.

KLEIN, B. 1928. Die Silberliniensysteme der Ziliaten. Weitere Resultate. *Arch. Protistenk.*, 62: 177–260.

LEGER, L., and O. DUBOSCQ. 1904. Nouvelle récherches sur les Gregarines et l'épithelium intestinal des Trachéates. *Arch. Protistenk.*, 4: 335–383.

LEWIN, K. 1910. Nuclear relations of *Paramecium caudatum* during the asexual period. *Proc. Camb. phil. Soc.*, 16: 39–41.

LILLIE, F. 1896. On the smallest parts of *Stentor* capable of regeneration; a contribution on the limits of divisibility of living matter. *J. Morph.*, 12: 239–249.

LUND, E. J. 1917. Reversibiity of morphogenetic processes in *Bursaria*. *J. exp. Zool.*, 24: 1–34.

LWOFF, A. 1949. Kinetosomes and the development of ciliates. *Growth*, 13, Suppl. (Symp. IX): 61–91.

——. 1950. *Problems of Morphogenesis in Ciliates*. J. Wiley & Sons, New York.

MACLENNAN, R. F. 1937. Growth in the ciliate *Ichthyophthirius*. I. *J. exp. Zool.*, 76: 423–440.

MARTINI, E. 1905. Beobachtungen an *Arcella vulgaris*. *Z. wiss. Zool.*, 79: 574–619.

MAUPAS, E. 1889. La réjeunissement karyogamique chez les ciliés. *Arch. Zool. exp. gén.*, 7: 149–517.

MAZIA, D., and H. E. HIRSHFIELD. 1950. The nucleus-dependence of P^{32} uptake by the cell. *Science*, 112: 297–299.

METZ, C. B., D. R. PITELKA, and J. A. WESTFALL. 1953. The fibrillar systems of ciliates as revealed by the electron microscope. *Biol. Bull.*, 104: 408–425.

MOORE, E. L. 1924. Regeneration at various phases in the life-history of *Spathidium spathula* and *Blepharisma undulans*. *J. exp. Zool.*, 39: 349–316.

MORGAN, T. H. 1901a. *Regeneration*. Macmillan, New York.

——. 1901b. Regeneration of proportionate structures in *Stentor*. *Biol. Bull.*, 2: 311–328.

MOSES, M. J. 1950. Nucleic acids and proteins of the nuclei of *Paramecium*. *J. Morph.*, 87: 493–536.

MUGARD, H. 1947a. Division et morphogénèse chez les Ophryoglènes. *C. R. Acad. Sci., Paris*, 225: 70–72.

——. 1947b. Division et morphogénèse chez les Phiasteridae et les Lembidae. *C. R. Acad. Sci., Paris*, 225: 141–143.

NANNEY, D. 1953a. Mating type determination in *Paramecium aurelia:* a model of nucleo-cytoplasmic interaction. *Proc. nat. Acad. Sci. Wash.*, 39: 113–119.

——. 1953b. Nucleo-cytoplasmic interaction during conjugation in *Tetrahymena*. *Biol. Bull.*, 105: 133–148.

NUSSBAUM, M. 1884. Über spontane und künstliche Zellteilung. *S. B. niederrhein. Ges. Nat.- u. Heilk. med. Abt.*, 41: 259–362.

——. 1886. Über die Teilbarkeit der lebendigen Materie. I. Die spontane und künstliche Teilung der Infusorien. *Arch. mikr. Anat.*, 26: 485–538.

OKADA, Y. 1930. Transplantationsversuche an Protozoen. *Arch. Protistenk.*, 69: 39–94.

PEEBLES, F. 1912. Regeneration and regulation in *Paramecium caudatum*. *Biol. Bull.*, 23: 154–170.

PENARD, E. 1900. Essais de mérotomie sur quelques Difflugies. *Rev. suisse Zool.*, 8: 477–490.

PHELPS, L. A. 1926. Experimental analysis of factors concerned in division in *Amoeba*. *Trans. Amer. micr. Soc.*, 45: 133–145.

PITELKA, D. R., and C. B. METZ. 1952. The structure of the "neuromotor apparatus" of *Paramecium* as revealed by the electron microscope. *Biol. Bull.*, 103: 282–283.

POPOFF, M. 1908. Experimentelle Zellstudien. *Arch. Zellforsch.*, 1: 245–379.

PROWAZEK, S. VON. 1904. Beiträge zur Kenntnis der Regeneration und Biologie der Protozoen. *Arch. Protistenk.*, 3: 44–59.

REYNOLDS, M. E. 1932. Regeneration in an amicronucleate infusorian. *J. exp. Zool.*, 62: 327–361.

RHUMBLER, L. 1902. Die Doppelschalen von *Orbitolites* und anderer Foraminiferen, vom entwicklungsmechanischen Standpunkt aus betrachtet. *Arch. Protistenk.*, 1: 193–296.

RUNYAN, E., and H. TORREY. 1914. Regulation in *Vorticella*. *Biol. Bull.*, 27: 343–345.

SCHMÄHL, O. 1926. Die Neubildung des Peristoms bei der Teilung von *Bursaria truncatella*. *Arch. Protistenk.*, 54: 359–430.

SCHNEIDER, A. 1867. Zur Kenntnis des Baues der Radiolarien. *Arch. Anat. Physiol. wiss. Med.*, 509–511.

SCHWARTZ, V. 1935. Versuche über Regeneration und Kerndimorphismus bei *Stentor coeruleus* Ehrbg. *Arch. Protistenk.*, 85: 100–139.

SESHACHAR, B. R. 1950. The nucleus and nucleic acids of *Chilodonella uncinatus*, Ehrbg. *J. exp. Zool.*, 114: 517–544.

——, and C. M. S. DASS. 1953. Macronuclear regeneration in *Epistylis articulata*. *Quart. J. micr. Sci.*, 94: 185–192.

SOKOLOFF, B. 1923. Hunger and regeneration. *J. R. micr. Soc.*, 183–189.

——. 1924. Das Regenerationsproblem bei Protozoen. *Arch. Protistenk.*, 47: 143–252.

SONNEBORN, T. M. 1932. Experimental production of chains and its genetic consequences in the ciliate protozoan *Colpidium campylum* (Stokes). *Biol. Bull.*, 63: 187.

——. 1946. Inert nuclei: inactivity of micronuclear genes in variety 4 of *Paramecium aurelia*. *Genetics*, 31: 231.

——. 1947. Recent advances in the genetics of *Paramecium* and *Euplotes*. *Advanc. Genet.*, 1: 263–358.

——. 1951. Some current problems of genetics in the light of investigations on *Chlamydomonas* and *Paramecium*. *Cold Spr. Harb. Symp. quant. Biol.*, 16: 483–503.

STEIN, F. 1859. *Der Organismus der Infusionsthiere nach eigenen Forschungen in systematischer Reihenfolge bearbeitet. I. Allgemeiner Theil und Naturgeschichte der hypotrichen Infusionsthiere*. Engelmann, Leipzig.

SUMMERS, F. 1941. Problems of morphogenesis. In *Protozoa in Biological Research* (Calkins and Summers, eds.). Columbia Univ. Press, New York.

TARTAR, V. 1938. Regeneration in the starfish *Linckia* and in the protozoan *Condylostoma*. *Rep. Tortugas Lab.*, 1937/38: 99–102.

——. 1939. The so-called racial variation in the power of regeneration in *Paramecium*. *J. exp. Zool.*, 81: 181–208.

——. 1941. Intracellular patterns in the morphogenesis and regeneration of ciliate protozoa. *Growth*, (Symp. V): 21–40.

——. 1953. Chimeras and nuclear transplantations in ciliates, *Stentor coeruleus* × *S. polymorphus*. *J. exp. Zool.*, 124: 63–104.

TAYLOR, C. V. 1928. Protoplasmic reorganization in *Uronychia uncinata*, n. sp., during binary fission and regeneration. *Physiol. Zool.*, 1: 1–25.

——, and W. FARBER. 1924. Fatal effects of the removal of the micronucleus in *Euplotes*. *Univ. Calif. Pub. Zool.*, 26: 131–144.

VERWORN, M. 1888. Biologische Protisten-Studien. *Z. wiss. Zool.*, 46: 455–470.

VILLENEUVE-BRACHON, S. 1940. Récherches sur les Ciliés heterotriches. *Arch. Zool. exp. gén.*, 82: 1–100.

WALLENGREN, H. 1901. Zur Kenntnis des Neubildungs- und Resorptionsprozesses bei der Theilung der hypotrichen Infusorien. *Zool. Jb.*, Abt. Anat., 15: 1–58.

——. 1902. Inanitionserscheinungen der Zelle. Untersuchungen an Protozoen. *Z. allg. Physiol.*, 1: 67–128.

WEBB, W. 1855. On the *Noctiluca miliaris*. *Quart. J. micr. Sci.*, 3: 102–106.

WEISZ, P. B. 1948a. Time, polarity, size, and nuclear content in the regeneration of *Stentor coeruleus*. *J. exp. Zool.*, 107: 269–287.

——. 1948b. The role of carbohydrate reserves in the regeneration of *Stentor* fragments. *J. exp. Zool.*, 108: 263–278.

——. 1949a. A cytochemical and cytological study of differentiation in normal and reorganizational stages of *Stentor coeruleus*. *J. Morph.*, 84: 335–364.

——. 1949b. The role of specific macronuclear nodes in the differentiation and the maintenance of the oral area in *Stentor*. *J. exp. Zool.*, 111: 141–156.

——. 1949c. The role of the macronucleus in the differentiation of *Blepharisma undulans*. *J. Morph.*, 85: 503–518.

——. 1950a. On the morphogenetic role of the macronucleus during conguation in *Blepharisma undulans*. *J. exp. Zool.*, 114: 293–304.

——. 1950b. A correlation between macronuclear thymonucleic acid concentration and the capacity of morphogenesis in *Stentor*. *J. Morph.*, 87: 275–286.

——. 1951a. An experimental analysis of morphogenesis in *Stentor coeruleus*. *J. exp. Zool.*, 116: 231–258.

——. 1951b. Homoplastic grafting in *Stentor coeruleus*. *Biol. Bull.*, 100: 116–126.

——. 1951c. A general mechanism of differentiation based on morphogenetic studies in ciliates. *Amer. Nat.*, 85: 293–311.

YAGIU, R. 1951. Studies on *Condylostoma spatiosum* Ozaki & Yagiu IV. The relationship between an injury and the power of division. *J. Sci. Hiroshima Univ.*, Ser. B, 12: 1–9.

——. 1952. Ibid. V. Abnormal Phenomenon caused by being kept in fresh water. *J. Sci. Hiroshima Univ.*, Ser. B, 13: 1–13.

YOUNG, D. B. 1922. A contribution to the morphology and physiology of the genus *Uronychia*. *J. exp. Zool.*, 36: 353–395.

YOUNG, D. 1939. Macronuclear reorganization in *Blepharisma undulans*. *J. Morph.*, 64: 297–353.

ZULZER, M. 1909. Bau und Entwicklung von *Wagnerella borealis* Mereschk. *Arch. Protistenk.*, 17: 135–202.

THE LIFE-HISTORY AND SYSTEMATIC RELATIONS OF THE MESOZOA

By HORACE W. STUNKARD

Department of Biology, New York University

THE Mesozoa comprise one of the most controversial groups in the entire animal kingdom. The disagreements about them concern their structure, life-history, method of reproduction, and zoological status. The confusion results from different interpretations of their morphology and developmental stages. The name, Mesozoa, was proposed by Édouard van Beneden (1876) for the dicyemid parasites of the renal organs of cephalopod mollusks, to express his belief that these organisms represent a subkingdom intermediate between the Protozoa and Metazoa. The notion that they constitute a distinct category of organisms, simpler in organization than other metazoans, still persists despite strong evidence that their simplicity is secondary and the result of parasitic adaptation. For example, Hyman (1940) stated, "If the structural features of the Mesozoa could be shown to be original and not degraded, the group would be of the utmost phylogenetic significance, as a stage between Protozoa and Metazoa. They would furnish proof that the first step in metazoan organization is the relegation of reproductive cells into the interior, that the original metazoan had a solid, not a hollow construction, and that the gastrea theory of Haeckel is definitely erroneous. But since it is impossible to decide on existing evidence that the anatomy of the Mesozoa is primitive in nature, their taxonomic position remains problematical. They are here taken at their face value as of a grade of construction lower than that of the coelenterates and are placed in an isolated position between the Protozoa and Porifera. This placing should not be taken to confer upon the Mesozoa any especial phylogenetic significance, although the author believes that their characters are in the main primitive and not the result of parasitic degeneration." Although Hyman noted that most zoologists regard the Mesozoa as degenerate flatworms, she designated the group as a phylum, lower than the sponges in taxonomic status.

The first known representatives of the group were the parasites of the renal organs of cephalopod mollusks. They were discovered, according to Nouvel (1948), by Cavolini (1787), and were described by Krohn (1839) and Erdl (1843). Von Kölliker (1849) reported that they had long been known to zoologists; he studied the parasites of *Octopus vulgaris* and *Octopus macropus* and identified all those found by him and by previous authors in other cephalopods as members of a single species which he named *Dicyema paradoxum*. The generic name, *Dicyema*, was selected by von Kölliker to denote the fact, first observed by him, that the animals produce two kinds of embryos, which he designated as "infusorienartig" and "wurmförmig." The two kinds of embryos had been observed and described by Erdl, who regarded them as developmental stages of single individuals. The specific name, *paradoxum*, was ignored by van Beneden (1876) and subsequent authors, until restored by Stunkard (1948). Wagener (1857) studied the dicyemids from *Eledone moschata* and *Sepia officinalis*, which he described as *Dicyema eledones* and *Dicyema gracile*. In an appendix to the work of Wagener, Claparède (1857) described *Dicyema mülleri* from *Eledone cirrhosa*. Van Beneden (1876) believed that each species of cephalopod harbored a single dicyemid species and that there was precise correspondence between the classification of hosts and their parasites. He restricted the genus *Dicyema* to the parasites of octopuses, for which he proposed new specific names, and erected new genera to contain the parasites of *Eledone*, *Sepia*, and *Sepiola*, respectively. In a more extensive study, van Beneden (1882) traced the development of the vermiform and infusoriform embryos. He noted that the two kinds are produced in different kinds of individuals. Those bearing vermiform

embryos were called nematogens and those bearing infusoriform embryos were called rhombogens. He described two new species, *Conocyema polymorpha* from *Octopus vulgaris*, and *Microcyema vespa* from *Sepia officinalis*. The two new genera were included in a new family, the Heterocyemidae (=Conocyemidae Stunkard, 1937) and in a new order, Heterocyemida, while the previously described genera were included in the family Dicyemidae. Furthermore, van Beneden proposed a class, the Rhombozoa, to contain the two orders, Dicyemida van Bendeen, 1876, and Heterocyemida van Beneden, 1882. The class Orthonectida, which had been erected by Giard (1877) to contain three species, *Rhopalura ophiocomae*, *Intoshia linei*, and *Intoshia leptoplanae*, was included with the class Rhombozoa to comprise the Mesozoa.

Hatschek (1888) noted similarity between the mesozoans and the planula larvae of certain Cnidaria; accordingly, in his system they were included, as the Planuloidea, in an appendix to the Coelenterata. Hartmann (1907) recognized protozoan features, and since he contended that the Mesozoa are simpler than any metazoan, he proposed the term Moruloidea as more appropriate than Planuloidea.

ORTHONECTIDA

The orthonectids are parasites of marine invertebrates and have been found in turbellarians, nemerteans, polyclad annelids, brittle-stars, and bivalve mollusks. Knowledge of the orthonectids is more complete than that of the dicyemids. These animals were reported first by Keferstein (1868) from the gut of *Leptoplana tremellaris* at St. Malo, and later by McIntosh (1874) from the body wall of *Lineus gesserensis*. Giard (1877) described an orthonectid from the brittle-star, *Ophiocoma neglecta* (=*Amphiura squamata*) at Wimereux, named it *Rhopalura ophiocomae*, and on it erected the class Orthonectida. He reported that the organism was a simple planula and existed in two forms, one elongate, the other ovoid. He found the species previously reported from *L. gesserensis*, which he described as *Intoshia linei*; the species from *L. tremellaris* was designated *Intoshia leptoplanae*. The latter species was described by Jourdain (1880) as *Prohelminthus hessi*, and later, Caullery and Mesnil (1901) transferred both species to *Rhopalura* as *R. linei* and *R. leptoplanae*. In three publications, Giard (1879a, b, 1880) made further observations on *R. ophiocomae* and described a second species, *Intoshia gigas*, from the same host. He stated that as a result of parasitism, these worms have been reduced to the state of a planula.

Meanwhile, Metschnikoff (1879a) had studied an orthonectid from *Amphiura squamata* at Spezia and described it as a new species, *Rhopalura giardi*, but later he (1879b) considered it identical with that of Giard. He showed that the elongate form of Giard is the male and that the ovoid form, described as *Intoshia gigas*, is the female of *R. ophiocomae*. The genus *Intoshia* was suppressed. In a later paper, Metschnikoff (1881) reported more detailed studies on *R. ophiocomae* and on a species, parasitic in *Lineus lacteus* at Messina, which he designated *Rhopalura intoshii*. He reported that the males and females of *R. ophiocomae* developed in different plasmodia, whereas those of *R. intoshii* developed in the same plasmodium, demonstrating that the former species is dioecious, whereas the latter is hermaphroditic. These studies led Metschnikoff to the belief that fertilization occurs outside the bodies of the hosts. Julin (1881, 1882) made further observations on the morphology of *R. ophiocomae* and deductions, in part incorrect, concerning the development. Saint-Joseph (1896) described *Rhopalura pterocirri* from the body cavity of *Pterocirrus macroceros*, and Fauvel (1896) reported a species of *Rhopalura* in *Ampharete grubei*. Caullery and Mesnil (1901) made a txonomic revision of the Orthonectida. They (1899a, b) had erected a new genus, *Stoecharthrum*, based on *S. giardi*, an hermaphroditic species parasitic in the annelid, *Scoloplos mülleri*, and later (1904) another genus, *Pelmatosphaera*, based on *P. polycirri*, parasitic in the annelid *Polycirrus haematodes*. Atkins (1933) described *Rhopalura granosa* from the clam *Heteranomia squamula*. Nouvel (1935a) applied silver-impregnation techniques in a systematic study of the orthonectids and (1939) made further additions to a knowledge of their morphology, especially that of the males.

The life-cycle of the orthonectids has been disclosed by the several investigations of Caullery and his collaborators, Mesnil and Lavallée (bibliography in Caullery and Lavallée, 1912). Certain species are hermaphroditic but the majority are dioecious. Most of the work has been done on *R. ophiocomae*. In this species, the males and females are produced in different plasmodia; they escape from their hosts in the late afternoon and swim in the sea. The females are inseminated; spermatozoa penetrate the ova, which then undergo maturation divisions. The

polar bodies are extruded on long, conical projections; the pronuclei fuse, and the ova develop to ciliated larvae in the bodies of the females. Cleavage is unequal and results in a morula-like structure, in which a larger, central cell is enveloped by smaller peripheral cells (Mesnil and Caullery, 1905a; Caullery and Lavallée, 1908, text-fig. II, A–F and Pl. XV, figs. 31–40). During this time, chromatin granules are eliminated from certain of the cells, a phenomenon which was puzzling to the authors but which acquires marked significance in the light of McConnaughey's (1951) findings on chromatin elimination in the dicyemids. The larva consists of a superficial layer of ciliated cells with a few germinal cells in the interior. The cortical cells at the anterior end of the larva may contain refringent granules. These larvae emerge through the genital pore of the female orthonectid and enter the genital ducts of the brittle-star. Here they disintegrate and the germinal cells penetrate host cells, multiply asexually, and give rise to the plasmodia in which males or females are produced. The germinal cells form morular masses, which may dissociate and spread the infection throughout the body of the brittle-star (Caullery and Lavallée, 1910). The gonads of the host are usually destroyed.

During the summer of 1939, I was able to repeat and confirm the earlier observations on the developmental cycle of *R. ophiocomae*. The multiplicative process in the brittle-star is clearly one of polyembryony, comparable to that in the asexual generations of the digenetic trematodes, as described by Cort (1944).

DICYEMIDA

Knowledge of the dicyemids is less complete than that of the orthonectids. The stages in the renal organs of cephalopods have been described, but the life-cycle is known only in part. Each of these organisms consists of a single, large axial cell, enclosed in a covering of ciliated cells, the most anterior of which are differentiated to form the calotte, which is in contact with or embedded in the tissue of the host. The calotte comprises two circles of cells. Van Beneden (1876) designated the cells of the anterior circle, propolars; those of the posterior circle, metapolars; and the two cells immediately adjacent to the calotte, lateral in position, as parapolars. Wheeler (1899) designated the two terminal cells uropolars; the other superficial cells, spirally arranged and variable in number, as diapolars. The axial cell contains, in addition to its nucleus, a number of germinal cells which are concerned in reproduction.

Earlier observations on the dicyemids were reviewed by Whitman (1883). He showed that the classification of van Beneden (1876, 1882) was untenable, that a cephalopod may harbor more than one dicyemid species, and that the same dicyemid species may occur in more than one species of cephalopod. Accordingly, he devised a new system of classification based on morphological rather than bionomic considerations. He recognized only two genera, *Dicyema*, in which the calotte comprises eight cells (four propolars and four metapolars) and *Dicyemennea*, in which there are four propolar and five metapolar cells. He noted that in the genus *Dicyema*, "The propolars are always two dorsal and two ventral, and are *opposite* the corresponding metapolar cells, except in *Dicyema truncatum* where the metapolars are two lateral, one dorsal, and one ventral (*alternate* order)." "The genus *Dicyemennea* . . . has a calotte composed of nine cells (enneamerous), four propolar and five metapolar. The propolars are two dorsal and two ventral, and always much smaller than the three dorsal (one median and two lateral) and two ventral metapolars." Whitman recognized cell constancy in the dicyemids and described ten species, seven in the genus *Dicyema* and three in the genus *Dicyemennea*. He reported that new infections, in very young cephalopods, consist of "primary" nematogens and that they produce only vermiform embryos, "that with the adult condition of the host there is a change of phase, the infection consists chiefly or entirely of rhombogens which produce infusoriform embryos and that later the same individual [which he termed diphygenic] may produce consecutively infusoriform and vermiform embryos." He showed that reproduction is limited to germinal cells present in the axial cell. In nematogens, these cells produce vermiform embryos, each of which contains a single axial cell with a central nucleus and two primary germinal cells. These larvae leave the parent and increase the intensity of the infection. When the rhombogen phase supervenes, each embryo produces only a few, "seldom more than four to eight" germinal cells. Each such cell then divides, extruding a "free nucleus" which he termed a "paranucleus," and which was compared with a polar body. The paranucleus lies in the axial cell, near the cell from which it arose, to which the term "germogen" was applied. The germogen by division produces a cell group which he called the

"infusorigen," comprising a large central cell, which contains a few germinal cells, and which is partially enclosed in a layer of peripheral cells. The peripheral cells enlarge, detach, undergo cleavage, and give rise to the infusoriform embryos. The infusorigen was considered by Whitman to be an individual which, after a period during which infusoriform embryos are produced, reverts to the formation of germinal cells and the production of vermiform embryos. The rhombogen thus becomes a "secondary" nematogen. Although no evidence of fertilization was observed, Whitman stated, "It is not improbable that one of the two modes of reproduction exhibited in the diphygenic individuals may be introduced by fecundation."

Nouvel (1933) proposed a new genus, *Pseudicyema*, to contain *Dicyema truncatum*; and Wheeler (1897) erected a genus, *Dicyemodeca*, for a new species, *D. sceptrum*, in which the calotte comprised ten cells. Both genera were suppressed by McConnaughey (1949), who gave keys to the known species of *Dicyemennea* and *Dicyema*. McConnaughey also suppressed *Microcyema* van Beneden, 1882, as a synonym of *Conocyema* van Beneden, 1882, suppressed the family Conocyemidae, and included the genus *Conocyema* with its three known species in the family Dicyemidae.

As noted, the life-cycle of the dicyemids is known only in part. Van Beneden (1876) concluded that the dicyemids multiply in the renal organs of cephalopods only by the formation of vermiform embryos; that the infusoriform embryos transmit the infection from one mollusk to another, either directly or by the intervention of another host in which it may accomplish a part of its development. Later, however, influenced by the observations of Metschnikoff and Julin on the orthonectids, he (1882) regarded the infusoriform larvae as males. This latter opinion was supported by Koeppen (1892), Wheeler (1897, 1899), and Hartmann (1904, 1907). In his earlier papers, reaffirmed in 1925, Hartmann described the life-cycle of the dicyemids as a "primary" alternation of generations with a primitive agametic type of reproduction which occurs among the Protozoa, but not among the Metazoa. For Hartmann, the infusorigens were females, the infusoriform individuals were males which arose from fertilized cells or directly from germinal cells. The reports of Hartmann were corroborated by Neresheimer (1908, 1932, 1933) and accepted by Schartau (1940).

Lameere (1916a, b) reported the discovery in the renal sacs of very young individuals of *Sepia officinalis* of new larval stages of *Dicyema truncatum* (= *Pseudicyema truncatum* of Nouvel) and of *Microcyema vespa*. The larva of *D. truncatum* is only about 70 micra long; it has 3 parapolar cells, a single uropolar, 27 diapolar cells, and 3 axial cells, each of which contains a single germinal cell in addition to its nucleus. This larva increases three to four times its original size, to become what Lameere designated the "nématogène fondateur." The germinal cells produce primary nematogens typical of *D. truncatum*, each about 70 micra long, with 2 parapolars, 20 diapolars, 2 uropolars, and a single axial cell. Nouvel (1947) referred to this larva as "La larve immigrante" (p. 117) and as "la génération d'infestation des Dicyémides" (p. 135). Since it becomes the "nématogène fondateur," he proposed to call it the "larve fondatrice" (Fig. 1). The larva of *M. vespa* also contains three axial cells, and Lameere (1916b) described its transformation into the "nématogène fondateur," which produces the primary nematogens of that species. In subsequent papers, Lameere (1917, 1918, 1919, 1922) made further contributions to knowledge of the dicyemids. He (1918) adopted the idea of Whitman that the infusorigen is an individual enclosed in the axial cell of the rhombogen (Fig. 2) and the suggestion of Mesnil and Caullery (1905b) that it is hermaphroditic. The peripheral cells which develop into infusoriform larvae were identified as ova, and the germinal cells within the large central cell were described as spermatocytes, which by meiotic divisions produced spermatozoa. These minute, chromatic bodies entered the ova, which then emitted two polar bodies, and after fusion of the pronuclei developed into the infusoriform larvae. According to Lameere, in the formation of the infusorigen a germinal cell divides, expelling a

FIG. 1. "LARVE FONDATRICE"

With 3 parapolar and 3 axial cells; infects the young octopus and develops into the "nématogène fondateur"; cilia omitted. After Lameere, 1916.

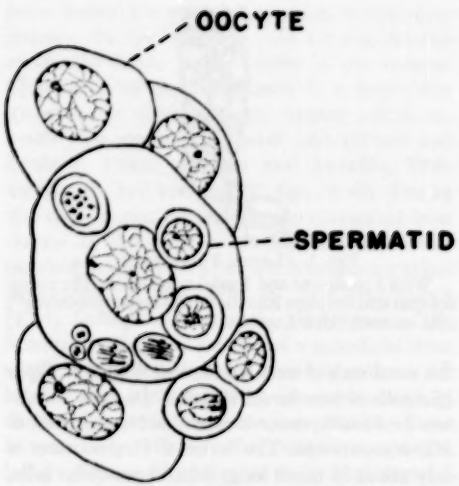

FIG. 2. YOUNG INFUSORIGEN IN A RHOMBOGEN
When the octopus becomes sexually mature the nematogens transform into rhombogens, the axoblasts cease to divide, most of them degenerate, and a few develop into infusorigens. The latter are hermaphroditic individuals; the large central cell contains spermatocytes and spermatozoa, and the adherent cells are oocytes which develop into infusoriform larvae and leave the rhombogen and the octopus. Figure after Lameere, 1917.

paranucleus; the resulting cell divides again, and one of these cells is the first oogonium and by division gives rise to all the ova. The other cell then divides to form the first spermatogonium and a sister cell which engulfs the first spermatogonium and becomes the large, central cell of the infusorigen. Lameere traced cell lineage in the development of the nematogen of *Dicyema truncatum*.

In a series of papers, Nouvel (1929 to 1948, bibliography in 1948) reported on the morphology, cytology, physiology and biology of previously described and new dicyemid species. He (1935b) described the immigrant larva and "nématogène fondateur" of *Dicyemennea eledones* and in the next three years made further observations on the embryology and development of the dicyemids, confirming in general the findings of Lameere.

Gersch (1938a, b) stated that Hartmann's account of the life-cycle is erroneous; that the infusoriforms are not males, but larvae. He was unable to find the "nématogène fondateur" in renal organs of the several cephalopod species examined at the Statione Zoologica di Napoli, and the observations of Lameere and Nouvel concerning this stage in the life-cycle of the dicyemids were dismissed as faulty observations based on artifacts. Reproduction in the cephalopod was described as entirely asexual and separated into two phases. The first was multiplicative, in which germinal cells (axoblasts) in nematogens produced vermiform larvae. Then followed a dispersive phase in which the infusorigens, which he regarded as vermiform larvae with arrested development, "umgewandelte wurmförmige Embryonen," and termed "Bildungsherde," produced "Pseudo-Eizellen" that developed into the infusoriforms which he designated as "Schwärmlarven." Gersch could find no evidence for sexual phenomena or maturation stages in the "Pseudo-Eizellen." He stated, "Allerdings ist die Möglichkeit parthenogenetischer Fortpflanzung noch immer gegeben, nachdem die von anderen Autoren beschriebenen Befruchtungsvorgänge als widerlegt betrachtet werden müssen. Da keine Reifeteilungen auftreten, würde es sich um eine diploide Parthenogenese handeln" (1938b, p. 595). The heterocyemids of earlier authors were regarded as merely degenerative stages of exhausted rhombogens. Gersch declared, "die 'Heterocyemiden' sind ohne weiteres als defekte, missgebildete oder zerfallene Dicyemiden anzusprechen" (p. 562). Unable to infect cephalopods by exposure or to maintain the infusoriform larvae, Gersch postulated another as yet unknown phase in the life-cycle of the dicyemids.

Hartmann (1939) and Schartau (1940) contended that Gersch was mistaken in regarding the heterocyemids as degenerate dicyemids and maintained that they are valid species in a distinct family. Meanwhile, Stunkard (1937) had pointed out that the family name, Heterocyemidae van Beneden, 1882, is invalid, since there is no genus *Heterocyema*. For the family, he proposed the name, Conocyemidae, with *Conocyema* as the type genus.

In a monographic treatise, Nouvel (1947–1948) has given an exhaustive account and bibliography of previous work on the dicyemids and the results of his long study of these parasites. The paper contains descriptions of all previously known and two new species. Nouvel derided the account of Gersch and confirmed the observations of Lameere on the existence of immigrant larval and "nématogène fondateur" stages. He stated, "Quant aux fondateurs de *Ps. truncatum* et *Microcyema vespa*, n'importe qui peut les observer; à Roscoff, par exemple, il suffit de faire un frottis de corps spongieux d'une très jeune *Sepia officinalis*: tous mes frottis confectionnés avec des Seiches dont le sépion mesure de 9 à 23 mm, *sans exception*, en

contiennent" (1947, p. 137). He described the larvae and fondateurs of *Dicyema truncatum*, *Dicyema schulzianum*, and *Dicyemennea eledones*, and the fondateur generation of *Dicyema typus*, *Dicyema paradoxum* (=*Dicyema clausianum*), *Dicyema rondeletiolae*, and *Dicyema misakiense*. The development of the nematogens and rhombogens was traced; also the origin and fate of the germinal cells. Nouvel described the infusorigens as hermaphroditic individuals in which "la spermatogénèse s'effectue à l'interieur, l'oogénèse à l'exterieur de la cellule axiale." In *Dicyema schulzianum* he described spermatogenesis, with reduction at the heterotypic division and the formation of minute, amoeboid spermatozoa. In this species the diploid number of chromosomes was reported to be eighteen. He stated that all divisions of the oogonia are equational, that there is no reductional division, and that the secondary oocytes are diploid. At the prophase of each division of the oocytes there is a bouquet stage of the chromosomes which indicates a meiotic division, but it is abortive, and the secondary oocytes, which may divide repeatedly, remain diploid. He reported that the secondary oocyte, while in contact with the axial cell, is penetrated by a spermatozoon. A polar body is then extruded at the end of a long cytoplasmic protrusion, a feature which recalls the formation of polar bodies in the orthonectids. The polar body contained eighteen chromosomes. The sperm becomes pycnotic and is extruded. After extrusion of the polar body and spermatozoon, the resulting cell undergoes cleavage and develops into an infusoriform larva. In *Dicyemennea lameeri* the diploid number of chromosomes was reported to be fourteen and the meiotic phenomena were similar to those in *Dicyema schulzianum*. Nouvel stated, "les Dicyémides offrent donc un exemple bien caractérisé de *pseudogamie*" (p. 219). In the second part of his monograph, Nouvel (1948) described the development and structure of the infusoriform larvae, abnormalities in different stages, repartition among host species, and the zoological position of the dicyemids.

McConnaughey (1949) revised and simplified the classification of the Dicyemidae. He recognized thirty-one valid species, nine of them new to science, which were included in three genera, *Dicyema*, *Dicyemennea*, and *Conocyema*. Keys were provided to species. The genus *Pseudicyema* Nouvel, 1933, was suppressed and the only species, *P. truncatum*, was restored to *Dicyema*. The genus *Dicyemodeca* Wheeler, 1897, was declared invalid, since it was based on abnormal specimens. *Microcyema* von Beneden, 1882, was listed as a synonym of *Conocyema* van Beneden, 1882; and *M. vespa* was transferred to *Conocyema* as *C. vespa*. A new species, *Conocyema adminicula*, was compared with species of *Dicyemennea* and a possible relationship was noted. Discovery of the "nématogène fondateur" (stem-nematogen of Hyman, 1940) confirmed the accounts of Lameere and Nouvel as to the existence of this stage in the life-cycle. Earlier accounts of dicyemids on the Pacific coast stated that the host was *Octopus bimaculatus*, but in this paper McConnaughey noted that two species of *Octopus* were involved. In a separate publication, Pickford and McConnaughey (1949) distinguished between two sympatric, sibling species in the *Octopus* population of the southern California coast. One was identified as *Octopus bimaculatus* Verrill, 1883, the other was described as a new species, *Octopus bimaculoides*. Juvenile stages of the two species are indistinguishable, but adult stages harbor different species of dicyemids. *Dicyemennea californica* occurs only in *O. bimaculoides*; *Dicyemennea abelis* only in *O. bimaculatus*. Since the octopuses are infected when very young, there is obvious host-parasite specificity.

In a subsequent paper, McConnaughey (1951) made observations on the life-cycle of the dicyemids (Fig. 1). He confirmed the observations of Lameere and Nouvel on the stages in the cephalopod and made additions to the descriptions of the successive stages. He distinguished between the peripheral, somatic cells and the axial, reproductive cell of vermiform larvae (Fig. 4); confirmed the

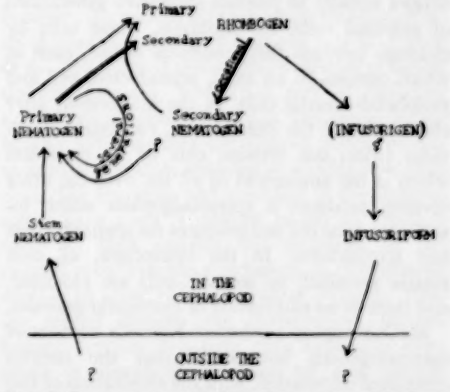

FIG. 3. DIAGRAM OF THE LIFE-CYCLE OF A DICYEMID
After McConnaughey, 1951

statement of Hartmann (1907) that in the cell divisions which give rise to somatic cells there is an elimination of chromatin granules. McConnaughey suggested that in species which manifest cell-constancy such chromatin elimination occurs in the divisions which produce somatic cells. In the vermiform larvae of dicyemennid species, the first division of the axial cell produces a small, abortive, anterior cell which was interpreted as a rudimentary, second axial cell and compared with the two or three axial cells of stem-nematogens, and the additional, anterior, abortive cells in the young larvae of that stage (Fig. 5). A similar division of the axial cell of the infusorigen produces the paranucleus. A later unequal division of the axial cell in both the vermiform embryo and the infusorigen cuts off the first germinal cell, which in

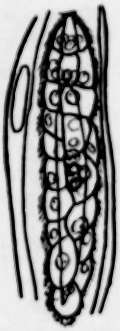

FIG. 4. VERMIFORM LARVA

With 2 parapolar cells and a single axial cell. These larvae develop from axoblasts and become nematogens. After McConnaughey, 1949.

the former instance invades the larger cell and divides equally to produce successive generations of germinal cells, the axoblasts. These cells by cleavage produce the vermiform larvae, each of which consists of an axial, reproductive cell and peripheral somatic cells. In the infusorigen, after elimination of the paranucleus, the axial cell divides twice; one division cuts off an oogonium which is the antecedent of all the ova; the other division produces a spermatogonium which invades the axial cell and produces the spermatogonia and spermatozoa. In the infusorigen, all cells remain germinal, no somatic cells are produced, and there is no elimination of chromatin granules.

McConnaughey confirmed Nouvel's account of spermatogenesis but found that the oocytes completed maturation, with the elimination of two

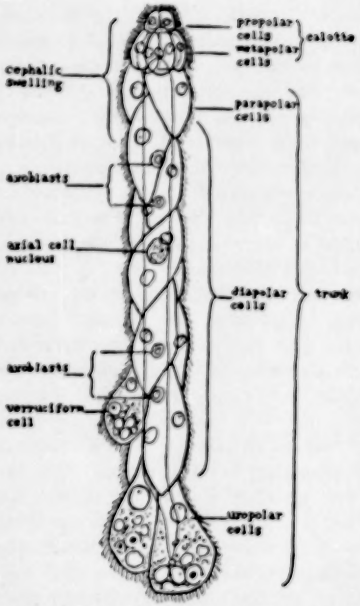

FIG. 5. YOUNG NEMATOGEN OF *Dicyemennea*

With single axial cell and 4 axoblasts, showing arrangement of the cortical cells. The axoblasts increase in number by mitosis. After McConnaughey, 1951.

polar bodies and reduction in the number of chromosomes. The polar bodies were eliminated at the ends of long cytoplasmic protrusions, as in the orthonectids. The spermatozoon was not extruded from the ovum; instead it formed a male pronucleus and the maternal and paternal chromosomes were distinct on separate spindles at the first cleavage. McConnaughey traced the embryology and described the morphology of the infusoriform larva. At the sixteen-cell stage, four germinal cells were recognized; they invaded the cells from which they were cut off. These cells comprise the contents of the urn, a cup-like structure which opens to the surface on the ventral side of the mature infusoriform. In species of *Dicyemennea* the nucleus of each invaded cell divides, so each of the four urn cells contains two nuclei and one germinal cell. The other cells of the infusoriform larva are somatic; they comprise eight cells ventral in position and anterior to the cavity of the urn, two of which face the cavity and bear cilia; two large cells which form a capsule around the urn and whose cytoplasm contains large granules which stain with neutral red, and

according to McConnaughey give a positive reaction in the aldehyde test for tryptophan; two cells, anterior and dorsal to the capsule of the urn, which store glycogen; and seventeen cells which bear cilia and cover the dorsal, lateral, posterior, and ventral aspects of the body. In addition, dorsal to the eight anteroventral cells, there are two anterior cells which contain the refringent bodies that comprise from one-fourth to one-third of the entire body of the larva. These clear, homogeneous, refringent bodies first appear as one or more small vesicles in the cytoplasm of each of the antero-dorsal cells. They increase in size until the cytoplasm is restricted to a film and the nucleus is greatly flattened. Around the antero-medial and ventral faces of the refringent bodies there are granules, similar in appearance to those in the capsular cells. The escape of the infusoriform from the rhombogen and its subsequent behavior were described by McConnaughey. These larvae leave the renal sacs of the octopus in the excretory fluid and may be collected in large numbers from the sea-water in which a sexually mature octopus has been isolated for a few hours.

Consideration of the physiology, life-cycles, and phylogeny of the parasitic flatworms (Stunkard, 1937) and preliminary observations on the dicyemids of *Octopus vulgaris* at Wimereux in 1939 had indicated that complete and precise information concerning the life-cycle of the dicyemids, the method of reproduction in the cephalopod host, and the discovery of the yet unknown stages in the life-cycle would aid in solving one of the most significant problems in theoretical zoology and elucidate the systematic relations of these enigmatic organisms. The contradictory accounts of Lameere and Nouvel and of Gersch had intensified the confusion and demonstrated the need for detailed and accurate knowledge of the multiplicative processes in the vermiform stages of the dicyemids. The publication by Nouvel (1947) of the first section of his monograph had reaffirmed and strongly supported his earlier observations, and all recent authors had agreed that there is an as yet undisclosed stage, probably parasitic in some other host, in the life-history of the dicyemids.

Accordingly, during the period February to August, 1948, I undertook a study of the dicyemid parasites of octopuses at the Scripps Institution of Oceanography, La Jolla, California. On my arrival there I found that Bayard H. McConnaughey, who had begun his studies in 1937 and had published in 1941 descriptions of two new species of *Dicyemennea*, had returned from military service and was completing a dissertation on the Mesozoa of the Pacific coast. The results of his studies have appeared in two publications, McConnaughey (1949, 1951). During the summer of 1948, the second section of Nouvel's monograph appeared. The findings of McConnaughey confirmed, in general, the observations of Lameere and Nouvel, although there are discrepancies in interpretation of the nature of the germinal cells in nematogens and in the accounts of spermatogenesis and oogenesis. McConnaughey found the némátogène fondateur and confirmed the existence of this stage in the life-cycle. Nouvel accepted the idea of Lameere that the germinal cells (axoblasts) of the nematogen are oogonia which develop parthenogenetically to produce the vermiform embryos. McConnaughey apparently regarded the formation of axoblasts as asexual, with gamete formation limited to the infusorigen. He reported chromatin diminution in the nuclear divisions which give rise to somatic cells and suggested that it is a feature of those animals in which the number of somatic cells is constant. In spermatogenesis, Nouvel (1947, p. 208) stated, "La première spermatogonie se divise aussitôt après qu'elle a pénétré dans la cellule axiale. Cette division est équationnelle: elle donne une nouvelle spermatogonie et un spermatocyte de permier ordre. Il en sera de même à chacune des bipartitions de la spermatogonie restante. Les spermatocytes de premier ordre donnent chacun deux spermatocytes de second ordre et *la division est réductionelle*." According to McConnaughey (1951, p. 316), "Some of the axoblast-like cells inside the axial cell of the infusorigen continue to multiply by mitotic divisions. Rather early, however, the nucleus in others swells up noticeably; its chromatin is gathered near one pole in strands or as small knots of chromatin on strands of lighter staining material, forming a sort of radiating anastomosing network of fibrils. The chromosomes become individualized and the cell undergoes two successive divisions, resulting in smaller cells each time. The smallness and crowding of the chromosomes have made it difficult to get an accurate count of their number but estimates on the clearest cases indicate a reduction in chromosome number by about half during these divisions. After the second division the chromosomes become lumped together in a tight little knot. The cytoplasm is almost all sloughed off and quickly disintegrates. The small tailless sperm lie scattered

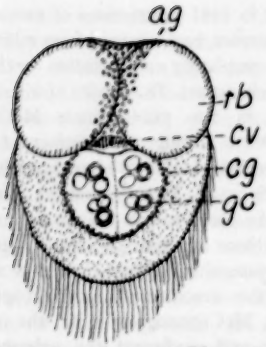

FIG. 6. INFUSORIFORM LARVA OF *Dicyemennea Abelis*
Stained with neutral red and Janus green B; diagrammatic; *ag*, anterior granules around the refringent bodies; *cg*, granules in the capsular cells; *cv*, cavity of the urn; *gc*, germinal cell; *rb*, refringent body. Original.

about near the periphery of the infusorigen and attach themselves to the mature oogonia at or near the point where these are attached to the infusorigen." As noted earlier, Nouvel reported the elimination of only one polar body from the oocyte and the expulsion of the spermatozoon before cleavage of the cell, whereas McConnaughey described formation of two polar bodies, retention of the spermatozoon, and its contribution to the chromatic constitution of the infusoriform larva.

Since McConnaughey was engaged in a study of the reproductive phases in the nematogen and rhombogen stages of the dicyemids, my efforts were directed primarily to the infusoriform larvae (Fig. 6) and to an attempt to discover the unknown stages in the life-cycle of these organisms. Descriptions of these larvae have been given by Nouvel (1948) and McConnaughey (1951). My observations were made on larvae from both *Octopus bimaculatus* and *O. bimaculoides*. Validity of the two species was confirmed by their behavior. A mature female of *O. bimaculatus* was placed in an aquarium with a mature male. The male approached the female, and mating, as reported by Fox (1938) and by Pickford and McConnaughey (1951), occurred with little preliminary courtship. The male displayed no interest in females of *O. bimaculoides*. Similarly, males of the latter species made no attempt to mate with females of *O. bimaculatus*, although they did court females of their own species. Two males of *O. bimaculoides* were placed in a small aquarium. Fighting began almost immediately, and the larger one chased the smaller one out of the water. This occurred repeatedly until the smaller individual was removed to another aquarium.

Twenty-six octopuses were collected. Fourteen of them, five *O. bimaculatus* and nine *O. bimaculoides*, were sexually mature and shed larvae; twelve octopuses were immature and did not liberate larvae, although on dissection all were found to contain nematogens. Collection of the infusoriform larvae was made by the method of McConnaughey. An octopus was kept for several hours in a small aquarium through which air was bubbled. The water was then transferred to a large separatory funnel, and the larvae, which go immediately to the bottom, were drawn off. Recently collected cephalopods sometimes shed many rhombogens as well as larvae, but on autopsy later, the infection had persisted. Only mature octopuses shed larvae, and after several weeks in the laboratory the number released was reduced, and in certain cases ceased entirely. The initial abundance and subsequent diminution in number of larvae may be correlated with the higher temperature of the laboratory, but not to inanition, since the hosts usually ate well in captivity. A similar phenomenon, viz., an initial outburst and gradual reduction in number of cercariae liberated by snails, is a common occurrence.

Examination of the hosts on autopsy showed that *O. bimaculatus* harbored *Dicyemennea abelis* and *Dicyemennea granularis*, and that *O. bimaculoides* harbored *Dicyemennea californica* and *D. granularis*. Specific determination of the vermiform stages was made by McConnaughey. The infusoriform larvae of *D. californica* and *D. abelis* are indistinguishable. They are 38–45 micra in length, the refringent bodies have a maximum size of 23 by 17 micra, and the urn measures 16 to 18 micra in diameter. The larvae of *D. granularis* may be slightly smaller and more pointed posteriorly, but as noted by Nouvel (1948, p. 154), "La taille des infusoriformes varie dans une même population et, à plus forte raison, dans des populations différentes." He stated that mature larvae, still in the rhombogen, begin degenerative changes. The somatic cells and nuclei become smaller, the cytoplasm more acidophilic, and the nuclei somewhat pycnotic. The cells of the urn swell, become spherical, and separate from each other. I noted that the granules around the refringent bodies begin to liquefy and that in preparations fixed with Duboscq-Brasil solution and stained with Ehrlich's acid hematoxylin, the

refringent bodies are the centers of purple areas. The color diminishes in intensity with distance from the refringent bodies. In preparations fixed with Schaudinn's fluid and stained with thionin, the color is black. As reported by McConnaughey (1951), the infusoriform liberates a substance which stains like the areas around the refringent bodies and which colors the fluid of the vacuole in which the larva lies. This substance apparently is derived from the granules around the refringent bodies.

The nature of the refringent bodies is problematical. Nouvel (1948, p. 150) stated, "Une étude histochimique des corps réfringents m'a permis d'affirmer que, chez certaines espèces au moins (*Ps. truncatum*, *D. typus*), ces organites sont constitués, en tout ou en grande partie, par de l'acide urique." These structures are solid, and pressure on a cover-glass causes them to break in a characteristic manner (Fig. 7). On treatment with acids the refringence is lost, almost instantly in HCl, more slowly in weak acids, acetic, tartaric, or oxalic. There is no effervescence, and a residual, flattened matrix persists. These bodies are not affected by alkalis, boiling water, alcohol, or xylol. When heated until the glass slide on which they were placed began to melt, one pair partially fused. By the use of polarized light, Dr. Alfred G. Fisher determined that the material is not anisotropic, and the cleavage pattern (Fig. 7) suggests that they are crystalline rather than amorphous. Their index of refraction is 1.52. They do not fluoresce in ultraviolet light. In many respects they resemble the excretory concretions of trematode larvae, studied by Macfarlane (1951), but the excretory granules of trematode larvae evolve CO_2 on treatment with acids. The refringent bodies of dicyemid larvae are probably not excretory, but secretory. They are not present in the vermiform stages, which must produce and dispose of excretory materials. These structures are present only in the two antero-dorsal cells of the larva, which should be able to diffuse excretory wastes as readily as other cells. To burden a larva with inert material to the extent of one-third to one-half of its weight does not appear to be of physiological value. It is more likely that the formation of the refringent bodies is of survival value for the species and plays a part in the completion of the life-cycle. Furthermore, the histochemical tests available are far from specific. Lison (1936) pointed out that the method of St. Hilaire, based on the insolubility of copper salts of purines, and the methods of Courmont and André, of Ciaccio and of Holland, based on the insolubility of silver salts and proposed for detection of purines, have absolutely no value. He stated, "Ainsi, la méthode de Kossa pour la détection du phosphatide de calcium est identique à une methode de Hollande qui met en evidence les urates."

FIG. 7. SKETCHES OF REFRINGENT BODIES
Crushed under a cover-glass, to show cleavage patterns. Original.

Respiration of the larvae is aerobic, as demonstrated by Nouvel (1933) and they live much longer in well aerated water. They die more quickly if cover-glass preparations are sealed.

The larvae were studied in sea-water, after staining with various vital dyes, and in solutions of methyl cellulose. Neutral red, Janus green, and methylene blue proved most useful of the vital dyes, and the granules in the capsular cells and those around the refringent bodies were stained selectively with neutral red. With Janus green B, the somatic cells stained lightly, and combinations Janus green B and neutral red provided desirable contrast. Methyl cellulose solutions slowed the beat of the cilia and permitted better observation of their movement. The cilia on the dorsal side beat more strongly than those on the ventral. The larvae usually rotate counter-clockwise, but may temporarily reverse the ciliary beat. They swim directly to the bottom of the container and never rise more than one or two millimeters from the substratum as a result of their ciliary activity, although currents in the water may carry them upward. They may swim rapidly, rotating on the long axis, but appear to bounce along, sometimes one or two cm. in a straight line, but more often changing direction frequently, especially if some obstacle is encountered. The swimming movements are strikingly like those of the miracidium of *Cotylophoron cotylophorum*, as described by Bennett (1936), who reported that when swimming rapidly the miracidia proceed in a straight line but follow a zigzag course at slower speeds and at times swim in a small circle. There is apparently no directional response by the infusoriform larvae to light or to other factors so far tested. McConnaughey found that tissues and extracts

made from various intertidal animals, placed in capillary tubes, elicited no response. When the cover-glass is close enough to exert a slight pressure or when the larva is spent, it swims in a circle in the same field of the microscope at 100 × magnification, without rotation and with the ventral side, which bears the opening of the urn, directed toward the center of the circle. The cells of the urn may then be extruded. McConnaughey (1951) reported such circling movements, followed by shedding of cilia and the prompt disaggregation of the individual. The larvae may swim for some time after the urn cells are voided, since individuals with empty urns were found among larvae that had been left over-night in sea-water. One other observation may be significant. When larvae were placed in a small drop of water, without a cover-glass, some of those which went to the edge of the drop, where they were subjected to pressure from the surface tension, expelled the contents of the urn. If sufficient pressure is applied to a cover-glass to crush the larva, the somatic cells disintegrate quickly, leaving the urn cells intact. Later the urn cells disintegrate, liberating the contained germinal cells.

DISCUSSION

Analyses of the structure and swimming behavior of the dicyemid larvae provide information that may be significant in disclosing the unknown stage in the life-cycle. The infusoriform larva consists of somatic cells and four germinal cells which are located in the four cells of the urn. The situation recalls that in the larva of the orthonectids, in the miracidial larva of digenetic trematodes, and in the onchospheral larva of the cestodes, where a few germinal cells are present, embedded in somatic tissues. All these larvae result from similar, unequal cleavage of fertilized ova, have bilateral symmetry, with no endoderm formation, and in the dicyemid and miracidial larvae, at least, the ciliated epidermal cells are constant and definite in number and position. In the more primitive cestodes, the onchosphere is encased by ciliated cells and becomes a free-swimming coracidium. None of these larvae can take food; all have a brief period of existence and serve merely to transmit the infection to the next host in the life-cycle. When the larvae of the orthonectids, digenetic trematodes, and cestodes arrive in their next hosts, the somatic cells degenerate and the germinal cells multiply to produce the next generation. Such multiplication is always asexual, since there is only one sexual phase in the life-cycle, and in the orthonectids and digenetic trematodes the number of progeny is increased by polyembryony. The germinal cells in these larvae are very similar, and the cleavage pattern in vermiform embryos of the orthonectids and dicyemids is strikingly like that in the asexual generations of digenetic trematodes.

It is almost certain that the weight of the refractile bodies causes the larvae of the dicyemids to be oriented with the anterior end downward, and that the ciliary beat drives them directly to the bottom, from which they are unable to rise. They swim in a bumbling fashion, in all directions, and since they live for only a day or two, they cannot move far from the area where they are passed by the cephalopod. Accordingly, they must find the next host quickly, and it is reasonably certain that their acquisition is incidental or accidental. It is probable that they are swept on or into the next host by water currents produced by that animal for respiratory purposes or for the collection of food particles. The minute size of the infusoriforms renders any attempt to follow them in the ocean practically hopeless and, since only the four germinal cells persist, the problem is increasingly complicated. The next host must be a bottom-living, sedentary, sessile or tubicolous species, probably ciliated for the production of water currents, and if the opinion of Stunkard (1937) concerning the phylogeny of the dicyemids is correct, a member of some group of great geologic age. If a larva becomes enmeshed in mucoid secretions or is subjected to pressure by structural components of the organism by which it has been inducted, the cells of the urn may be expelled or the somatic cells of the larva may disaggregate, freeing the germinal cells which then invade the tissues of the host and give rise asexually to plasmodial or sporocyst-like structures in which the "larve fondatrice" stage is produced. These ciliated larvae, which measure less than one hundred micra in length, would not be seen in ordinary dissections. If noticed, they would probably be regarded as protozoans unless the observer were actually looking for them. So, discovery of the next host and elucidation of the life-cycle will probably be accidental unless a microscopic examination of possible hosts is routinely made. As the structure and behavior of the infusoriform larvae gave clues to the nature of the next host, various possible, sessile or sedentary invertebrates were collected and examined,

but without finding developmental stages of dicyemids. Since all octopuses become infected in the first few weeks of life, and do not migrate extensively during that period, the intermediate host must be relatively common and abundant, but ignorance concerning its identity, its location, and the incidence of infection renders such a method very precarious. The alternative method, more promising, requires experimental infection in the laboratory, but such procedure is time-consuming, since the number of possible hosts is enormous and many weeks may be required for the infection to reach an identifiable stage. Furthermore, it is difficult to maintain many possible hosts for long periods under laboratory conditions.

The early observers, Krohn (1839), Erdl (1843), Claparède (1857), Claparède and Lachmann (1861), and P. J. van Beneden (1875), presumed that the mesozoans were related to the Protozoa; Hatschek (1888) included them with the coelenterates as Planuloidea; but most zoologists are agreed that they are flatworms, secondarily simplified as a result of parasitism. Von Siebold (1845), von Kölliker (1849), Lankester (1873), Giard (1877), Metschnikoff (1881), Leuckart (1882), Braun (1893), Whitman (1883), Koeppen (1892), Caullery and Mesnil (1899, 1901), Stunkard (1937), and Nouvel (1948) have presented strong evidence for the derivation of the Mesozoa from platyhelminth progenitors. Lameere (1918) noted a resemblance between the mesozoans and the dwarf, parasitic males of *Bonellia* and postulated a genetic relationship, but the similarity is obviously analogous rather than homologous, and in both instances the result of parasitism. The idea of Édouard van Beneden, Hartmann, and Hyman that the structure of the mesozoans is primitive and not the result of parasitic degeneration appears to controvert established biological principles. It was refuted by the statement of Whitman (1883) that "when we find an animal in the form of a simple sac, filled with reproductive elements, secured by position against enemies, supplied with food in abundance, and combining parasitism with immobility, we have strong reasons for believing that the simplicity of its structure is more or less the result of the luxurious conditions of life which it enjoys, even if its development furnishes no positive evidence of degeneration."

It is stretching credulity too far to accept as primitively simple the structure of animals in which holozoic nutrition has been supplanted by parasitism; in which there is no trace of endoderm or digestive tract; in which there is almost complete regression of somatic structures; and in which the life-cycle is complicated by alternation of generations and the interpolation of accessory methods of reproduction. It would be as reasonable to maintain that the structure is primitive in cestodes, acanthocaphalans, and monstrillid copepods, which never have digestive tracts, or in the adult stages of enteroxenid snails, pentastomes, or cirripedians like *Sacculina*, although in the latter instances the larval stages provide evidence of relationship and indicate the course of past history. The simplicity of structure in the mesozoans is clearly secondary and the result of parasitism. Although the sexually mature stages of the orthonectids occur free in the ocean, they also are highly modified, short-lived forms, unable to feed, which now serve merely for reproduction and dispersal of the species. Although the orthonectids and dicyemids have many common features, the differences in the sexual stages suggest that they are not closely related and both probably have a very long history of parasitism.

Stunkard (1937) reviewed the evidence then available pertaining to the physiology, life-cycles, and phylogeny of the parasitic flatworms. He stressed the importance of life-history studies in evaluating systematic relations. As further criteria for phylogenetic determination he listed habitat, degree of regressive change, and extent of adaptation. He wrote, "The pronounced degeneration of many parasitic flatworms, involving the more or less complete loss of the digestive tract and the interpolation of accessory methods of reproduction, indicate a very long period of parasitic existence." He noted that closely related species of digenetic trematodes infect marine and freshwater hosts that have been distinct since the Mesozoic era. From a consideration of cleavage patterns, developmental stages, life-cycles, and morphological adaptations to parasitism he stated, "It is almost certain that members of the phylum became parasites of invertebrates in early geologic time and it is probable that the Mesozoa are surviving representatives of that early association. It is probable that the cestodes and digenetic trematodes also are survivors from that period, which have added vertebrate hosts in their life-cycles and have become biologically more successful. From a hypothetical, generalized, planuloid progenitor it is possible to derive each of the existing groups of the phylum Platyhelminthes.

Accordingly, it appears that the Turbellaria, Mesozoa, Cestoda, and Digenea have descended concomitantly from a common ancestral group of planula-like progenitors." Information accumulated since 1937, and reviewed in the present paper, strongly supports and confirms the earlier conclusions. The idea that the characters of the Mesozoa are primitive and that these animals comprise a distinct phylum, lower than the sponges in taxonomic status, can no longer be entertained. These parasites of invertebrates should be assigned the status of a class in the phylum Platyhelminthes.

SUMMARY

Review of previous information on the morphology, physiology, and development of the Mesozoa, together with observations on the free-living larval stages of the orthonectids and dicyemids, affords information concerning the as yet unknown intermediate host in the life-cycle of the dicyemids. Evidence is presented to show that the simplicity of the Mesozoa is secondary and that these organisms should be included as a class in the phylum Platyhelminthes.

ACKNOWLEDGMENTS

The studies on the orthonectides were conducted, while a fellow of the Oberlaender Trust of Philadelphia, Pa., at the Station Zoologique de Wimereux in the summer of 1939. Grateful appreciation is expressed to the Director, Professor Maurice Caullery, for facilities, freely and graciously extended, to study the life-history of *Rhopalura ophiocomae* in its type locality. The studies on the dicyemids were supported by a grant from the Alexander Dallas Bache Fund of the National Academy of Science and were conducted at the Scripps Institution of Oceanography, University of California, during the spring and summer of 1948. Facilities were provided by the Director, Dr. Carl H. Eckart, and generous assistance rendered by members of the staff. I wish to express thanks especially to Drs. Denis Fox, Carl Hubbs, W. R. Coe, and B. H. McConnaughey for the many favors received.

LIST OF LITERATURE

ATKINS, D. 1933. *Rhopalura granosa*, sp. nov., an orthonectid parasite of a lamellibranch, *Heteranomia squamula* L., with a note on its swimming behavior. *J. Mar. biol Ass. U. K.*, 19: 233–252.

BENEDEN, E. VAN 1876. Recherches sur les dicyémides, survivants actuels d'un embranchement des mésozoaires. *Bull. Acad. Belg. Cl. Sci.*, 2 sér., 41: 1160–1205; 42: 35–97.

——. 1882. Contribution à l'histoire des dicyémides. *Arch. Biol.*, 3: 195–228.

BENEDEN, P. J. 1875. *Les Commensaux et les Parasites dans le Règne Animal*. Paris.

BENNETT, H. J. 1936. The life history of *Cotylophoron cotylophorum*, a trematode from ruminants. *Illinois biol. Monogr.*, 14 (4): 1–119.

BRAUN, M. 1893. Mionelminthes Pgstchr. In Bronn's *Klassen und Ordnungen des Thier-Reichs*, 4: 252–302.

CAULLERY, M., and A. LAVALLÉE. 1905. Sur les larves ciliées produites par la femelle d'un orthonectide (*Rhopalura ophiocomae* Gd.). *C. R. Soc. Biol., Paris*, 59: 265–266.

——, and ——. 1908. La fécondation et le développement de l'oeuf des orthonectides. *Arch. Zool. exp. gén.*, 4 sér., 8: 421–469.

——, and ——. 1910. Recherches expérimentales sur les phases initiales de l'infection d'une ophiure (*Amphiura squamata*) par un orthonectide (*Rhopalura ophiocomae*). *C. R. Acad. Sci., Paris*, 150: 1781–1783.

——, and ——. 1912. Recherches sur le cycle évolutif des orthonectides. *Bull. sci. Fr. Belg.*, 46: 139–171.

——, and F. MESNIL. 1899a. Sur trois orthonectides nouveaux, parasites des annélides, et l'hermaphrodisme de l'un d'eux (*Stoecharthrum giardi* n.g., n. sp.) *C. R. Acad. Sci., Paris*, 128: 457–460.

——, and ——. 1899b. Sur l'embryogénie des orthonectides, et en particulier du *Stoecharthrum giardi*, Caull. et Mesn. *C. R. Acad. Sci., Paris*, 128: 516–519.

——, and ——. 1901. Recherches sur les orthonectides. *Arch. Anat. micr.*, 4: 381–470.

——, and ——. 1904. Sur un organisme nouveau (*Pelmatosphaera polycirri* n.g., n. sp.) parasite d'un annélide (*Polycirrus haematodes* Clap.) et voisin des orthonectides. *C. R. Soc. Biol., Paris*, 56: 92–95.

——, and ——. 1905. Phénomènes de sexualité dans le développement des actinomyxidies. *C. R. Acad. Sci., Paris*, 140: 1482–1484.

CAVOLINI, F. 1787. *Memoria sulla Generazione dei Pesci e dei Granchi*. Napoli. (Cited after Nouvel, 1948).

CLAPARÈDE, E. 1857. Appendice au travail de Wagener. *Müller's Arch.*, 1857: 354.

——, and J. LACHMANN. 1861. Études sur les infusoires et les rhizopodes. *Mém. Inst. nat. génev.*, 7 (3): 201–206.

CORT, W. W. 1944. The germ cell cycle in the digenetic trematodes. *Quart. Rev. Biol.*, 19: 275–284.

ERDL. 1843. Ueber die beweglichen Fäden in den Venenanhängen der Cephalopoden. *Arch. Naturgesch.*, 1: 162–167.

FOX, D. L. 1938. An illustrated note on the mating

and brooding habits of the two-spotted octopus. *Trans. S. Diego Soc. nat. Hist.*, 9: 31–34.

FAUVEL, P. 1896. Un *Rhopalura* chez l'*Ampharete grubei*. *Bull. Soc. linn. Normandie*, 4 sér., 10: 1–11.

GERSCH, M. 1938a. Untersuchungen über die Fortpflanzung der Dicyemiden. *Verh. dtsch. zool. Ges.*, 40: 64–71.

——. 1938b. Der Entwicklungszyklus der Dicyemiden. *Z. wiss. Zool.*, 151: 515–605.

GIARD, A. 1877. Sur les Orthonectida, classe nouvelle d'animaux parasites des échinodermes et des turbellariés. *C. R. Acad. Sci., Paris*, 85: 812.

——. 1879a. Sur l'organisation et la classification des Orthonectida. *C. R. Acad. Sci., Paris*, 89: 545–547.

——. 1879b. Les Orthonectida, classe nouvelle du phylum des Vermes. *J. Anat., Paris*, 15: 449–464.

——. 1880. The Orthonectida, a new class of the phylum of the worms. *Quart. J. micr. Sci.*, n.s., 20: 225–240.

HARTMANN, M. 1904. Fortpflanzungsweisen der Organismen. Neubenennung und Einteilung derselben, erläutert an Protozoen, Volvocineen und Dicyemiden. *Biol. Zbl.*, 24: 18–61.

——. 1907. Untersuchungen über den Generationswechsel der Dicyemiden. *Mém. Sci. Acad. Belg.*, n.s., 1: 1–128.

——. 1925. Mesozoa. In *Handbuch der Zoologie*, Kükenthal und Krumbach, 1: 996–1014.

——. 1939. Gibt es Heterocyemiden? *Z. wiss. Zool.*, 152: 83–88.

HATSCHEK, B. 1888. *Lehrbuch der Zoologie*. G. Fischer, Jena.

HYMAN, L. H. 1940. Phylum Mesozoa. In *The Invertebrates*, vol. 1. McGraw-Hill, New York.

JOURDAIN, S. 1880. Sur un forme des vers, le *Prohelminthus Hessi* S. J. = ? *Intoshia leptoplanae* A. Giard. *Rev. Sci. nat. Montpellier et Paris*, 2 sér., 2: 68.

JULIN, C. 1881. Observations sur le développement des orthonectides. *Bull. sci. Depart. Nord.* 2 sér. 4e année, Nos. 10–11.

——. 1882. Contribution à l'histoire des mésozoaires. Recherches sur l'organisation et le développement embryonnaire des orthonectides. *Arch. Biol.*, 3: 1–54.

KEFERSTEIN, W. 1868. Beiträge zur Anatomie und Entwicklungsgeschichte einer Seeplanarien von St. Malo. *Abh. Ges. Wiss. Göttingen*, 14: 3–38.

KOEPPEN, N. A. 1892. Nabliodenia nad razmnogeniem Ditziemid. *Soc. Sci. Nat. Odessa*, 17: 25–102. (cited after Nouvel, 1948).

KÖLLIKER, A. VON 1849. Ueber *Dicyema paradoxum*, den Schmarotzer der Venenanhänge der Cephalopoden. *Ber. kgl. zool. Anstalt. Würzburg*, 1847/1848, No. 8: 59–66.

KROHN, A. 1839. Über das Vorkommen von Entozoen und Krystallablagerungen in den schwammigen Venenanhängen einiger Cephalopoden. *Froriep's "Neue Notizen"*, 11: 213–216.

LAMEERE, A. 1916a. Une phase nouvelle des dicyémides. *C. R. Acad. Sci., Paris*, 163: 16–18.

——. 1916b. Contributions à la connaissance des dicyémides (1re partie). *Bull. sci. Fr. Belg.*, 7 sér. 50: 1–35.

——. 1917. Le cycle évolutif des dicyémides. *Bull. Soc. zool. Fr.*, 42: 122–126.

——. 1918. Contributions à la connaissance des dicyémides (2e partie). *Bull. biol.*, 51: 347–390.

——. 1919. Contributions à la connaissance des dicyémides (3e partie). *Bull. biol.*, 53: 234–275.

——. 1922. L'histoire naturelle des dicyémides. *Bull. Acad. Belg. Cl. Sci.*, 8 (12): 779–792.

LANKESTER, R. 1873. Summary of observations made at Naples in the winter of 1871–1872. *Ann. Mag. nat. Hist.*, 11 (4): 81–97.

LEUCKART, R. 1882. Zur Entwicklungsgeschichte des Leberegels. *Arch. Naturgesch.*, 48 Jahrg. 1: 95–96.

LISON, L. 1936. *Histochemie Animale*. Gauthier-Villars, Paris.

MACFARLANE, W. V. 1951. The life cycle of *Stegodexamene anguillae* n.g., n. sp., an allocreadiid trematode from New Zealand. *Parasitology*, 41: 1–10.

MCCONNAUGHEY, B. H. 1941. Two new Mesozoa from California, *Dicyemennea californica* and *Dicyemennea brevicephala* (Dicyemidae). *J. Parasit.*, 27: 63–69.

——. 1949. Mesozoa of the family Dicyemidae from California. *Univ. Calif. Publ. Zool.*, 55: 1–34.

——. 1951. The life cycle of the dicyemid Mesozoa. *Univ. Calif. Publ. Zool.*, 55: 295–336.

MCINTOSH, W. C. 1874. *A Monograph of the British Annelids. I. Nemerteans*. The Ray Society, London.

MESNIL, F., and M. CAULLERY. 1905a. Sur le développement des ovules et les larves ciliées d'un orthonectide hermaphrodite (*Rhopalura pelseneeri* Caull. et Mesn.). *C. R. Soc. Biol., Paris*, 59: 428–430.

——, and ——. 1905b. Comparaison des cycles évolutif des orthonectides et des dicyémides. *C. R. Soc. Biol., Paris*, 59: 431–433.

METSCHNIKOFF, E. 1879a. Zur Naturgeschichte der Orthonectiden. *Zool. Anz.*, 2: 547–549.

——. 1879b. Nachträgliche Bemerkungen über Orthonectiden. *Zool. Anz.*, 2: 618–620.

——. 1881. Untersuchungen über Orthonectiden. *Z. wiss. Zool.*, 35: 282–303.

NERESHEIMER, E. 1908. Die Mesozoen. *Zool. Zbl.*, 15: 257–312.

NERESHIMER E. 1932. Mesozoen. In *Handwörterb. Naturwiss.* 2 Aufl., 6: 849–860.

——. 1933. Mesozoa. In *Tierwelt Nord-u. Ostsee*, Grimpe u. Wagler, Lief. 25, Teil 11, 10 pp.

NOUVEL, H. 1933. Recherches sur la cytologie, la physiologie et la biologie des dicyémides. *Ann. Inst. océanogr. Monaco*, 13: 163–255.

——. 1935a. Application des techniques d'imprégnation argentiques à l'étude systématique des orthonectides. *Bull. biol.*, 69: 503–507.

——. 1935b. Le nématogène fondateur de *Dicyemennea eledones* Whit. et sa larve. *C. R. Acad. Sci., Paris*, 201: 1507–1509.

——. 1939. Nouvelles observations sur la morphologie des orthonectides. *Bull. Soc. zool. Fr.*, 64: 262–270.

——. 1947. Les Dicyémides. 1re partie: systématique, générations vermiformes, infusorigène et sexualité. *Arch. Biol.*, 58: 59–219.

——. 1948. Les Dicyémides. 2e partie: infusoriforme, tératologie, spécificité du parasitisme, affinités. *Arch. Biol.*, 59: 147–223.

PICKFORD, GRACE E., and B. H. MCCONNAUGHEY. 1949. The *Octopus bimaculatus* problem: a study in sibling species. *Bull. Bingham oceanogr. Coll.*, 12 (4): 1–66.

SAINT-JOSEPH, BARON DE 1896. *Rhopalura pterocirri* n. sp., orthonectide parasite d'une annélide. *Bull. Soc. zool. Fr.*, 21: 56–58.

SCHARTAU, O. 1940. Der Entwicklungszyklus von *Microcyema vespa* van Beneden (Heterocyemidae). *Pubbl. Staz. zool. Napoli*, 18: 118–128.

SIEBOLD, C. VON 1845. Bericht über die Leistungen im Helminthologie während der Jahre 1843 und 1844. *Arch. Naturgesch.*, XI Jahrg. 2: 247.

STUNKARD, H. W. 1937. The physiology, life-cycles, and phylogeny of the parasitic flatworms. *Amer. Mus. Novit.*, 908: 27 pp.

——. 1948. *Dicyema paradoxum* von Kölliker, 1849. *Science*, 108: 565–566.

WEGENER, G. R. 1857. Ueber *Dicyema* Köll., mitgetheilt in der Sitzung der naturforschenden Freunde zu Berlin. *Müller's Arch.*, Jahrg. 1857: 344–364.

WHEELER, W. M. 1897. Marine fauna of San Diego Bay. *Science*, 5: 775–776.

——. 1899. The life-history of *Dicyema*. *Zool. Anz.*, 22: 169–176.

WHITMAN, C. O. 1883. A contribution to the embryology, life-history, and classification of the dicyemids. *Mitth. zool. Sta. Neapel*, 4: 1–89.

NEW BIOLOGICAL BOOKS

The aim of this department is to give the reader brief indications of the character, the content, and the value of new books in the various fields of Biology. In addition there will occasionally appear one longer critical review of a book of special significance. Authors and publishers of biological books should bear in mind that THE QUARTERLY REVIEW OF BIOLOGY *can notice in this department only such books as come to the office of the editor. The absence of a book, therefore, from the following and subsequent lists only means that we have not recieved it. All material for notice in this department should be addressed to H. B. Glass, Associate Editor of* THE QUARTERLY REVIEW OF BIOLOGY, *Department of Biology, The Johns Hopkins University, Baltimore 18, Maryland, U. S. A.*

NEW DIRECTIONS IN GENETICS

BY ERNST CASPARI

Wesleyan University

A REVIEW OF GENES AND MUTATIONS. *Cold Spring Harbor Sympos. quant. Biol., Vol. XVI.*

The Biological Laboratory, Cold Spring Harbor, N. Y. $9.00. xvi + 521 pp.; ill. 1952.

This volume constitutes a symposium on the present state of genetics. The science of genetics has undergone profound changes in the last decade. It had appeared for some time as though the fundamental problems of genetics were either solved or close to solution, and that a consistent theory of the nature and action of the gene was within reach. This situation has profoundly changed; the fundamental concepts of genetics, the gene and gene mutation, have again become the subject of discussion and debate. While the different points of view of various authors have been given previously, this symposium was the first time in which a number of prominent geneticists had the opportunity to indicate their position on the fundamental problems of genetics at the same occasion. There is no agreement between the different authors on many points; but clear statements of their positions and of the experimental material on which those positions are based will enable the reader to judge where the problems of genetics lie at the present time, and how they are being approached. The value of this book extends therefore far beyond the interesting experimental and observational material included. It will form for many years to come a working program for geneticists. It appears certain that several of the contributions in this volume will remain among the classical papers in the science of genetics.

The volume consists of 35 papers, many of them with discussions. It appears impossible to review all of them at this time, or even to mention all of them. It seems preferable to discuss a number of points of more general interest which are commented upon by a number of different authors. It is indeed impressive to see how different workers in different fields are encountering the same problems, and how similar genetical situations in very different objects are reported all through the book.

The symposium is fittingly opened by a paper by Goldschmidt, who was the first to throw doubt on the classical concept of the gene. In this paper he summarizes the facts which led him to question the existence of the gene as described in classical genetics. This does not mean that he doubts the fundamental fact that mutational events at a particular locus of a chromosome will have effects on certain biochemical or developmental reactions. What is questioned is the validity of the "extrapolation from the mutant locus" (Goldschmidt) to the existence of a particulate genetic unit called a "normal gene" at this locus. The difficulty in principle of distinguishing between position effects and gene mutations leads Goldschmidt to reject the picture of a mutation as a changed gene particle. The validity of this new way of looking at mutations and genes will depend on how far it can lead to a deeper understanding of genetic facts.

This has been accomplished in the brilliant investigations of McClintock which have borne out a number of Goldschmidt's conclusions. McClintock has published in this volume for the first time her large material on unstable loci in maize, and since this work constitutes a major contribution to our knowledge of genes and mutations, I will attempt to summarize briefly some of its points, particularly those dealing with our concepts of genes and gene mutations. A chromosome locus *Ds* is described which causes mutational events at the place in the chromosome where it is located. These mutational events may either be chromosome breaks which may lead to chromosome rearrangements, or

mutations which affect a gene at or close to the location of *Ds*. For example, if *Ds* is situated at the *C* locus which controls anthocyanin formation in the endosperm, the phenotype of the cell will be that of the recessive allele *c*; this new *c* allele (c^{m1}) mutates spontaneously from *c* to *C* whenever *Ds* is lost. In other words, the action of the gene *C* has become changed to *c* under the influence of *Ds*, but it mutates frequently back to *C*. It is seen that this "instability arises from alterations that do not directly alter the genes themselves, but affect the functioning of the genic components at or near the locus of alteration" (McClintock). The type of mutational event taking place, i.e., the relative frequency of chromosome breaks and other types of mutation, depends on the condition or "state" of *Ds*; changes of state of *Ds* have been frequently observed. The mutational events taking place at *Ds* are controlled by another factor *Ac* which may even be situated in a different chromosome. *Ac* controls the time and place in development at which the mutational events will take place. The time and place of mutations will depend on the number of *Ac* alleles present in the nucleus, and on the "state" of *Ac*. Changes in state of *Ac* have also been found; they occur, just as mutational events at *Ds*, as a result of mitotic processes. Both *Ds* and *Ac* are regarded as being situated in heterochromatic regions.

In the course of the investigation described by McClintock a large number of other unstable genes arose at different loci. Many of them are distinguished from c^{m1} in their behavior and in the way in which they are controlled. Some of them lead to additional information concerning the nature and activity of genes. The general principle is, however, obvious from the short and incomplete statements given above, that the behavior and activity of a locus is controlled by the dosage and state of other chromatin structures in the nucleus.

The consequences of these new observations and concepts for the interpretation of the behavior of genes under different conditions cannot be reviewed here. It should however be pointed out that the control of mutational events and changes in state at mitosis by the dosage and state of *Ac* results in the formation of a pattern of genetically unequal cells. This provides a plausible mechanism for the origin of different types of cells, arranged in a regular pattern, during development. It is clear that such a view of developmental processes contradicts the usually accepted embryological idea of cytoplasmic control of determination, as introduced by Driesch, Boveri, Wilson, and Conklin, and resembles more closely the older hypotheses of development held by Weismann and Roux.

It should be clearly realized that the interpretation of mutations favored by McClintock and Goldschmidt does not contradict the evidence on which the classical picture of the gene is founded. As McClintock puts it: "It cannot be denied . . . that certain loci or regions in the chromosomes are associated in some manner with certain cellular reactions or with the development of particular phenotypic characters." It is, however, denied that from this association the conclusion can be drawn that genes are particulate units, situated at particular sites in the chromosomes. The fact, clearly demonstrated in McClintock's work, that changes in the organization of chromatic material may lead to mutational events, makes it unnecessary to assume a second different type of mutational event, a change in a gene particle.

Another argument Goldschmidt uses for his theory of the gene is derived from the existence of pseudoalleles. This problem recurs all through the symposium, pseudoallelic systems being described in animals, plants, and microorganisms. Psuedoalleles are systems of genes which behave phenotypically like multiple alleles but which are distinguished from each other by a small amount of crossing over between each other, or in some cases only by independent mutability. Some series of pseudoalleles seem to control different successive steps in biochemical processes, while others determine the developmental pattern in which a certain character is expressed. Two physiological explanations are suggested: consecutive chemical action on a substrate which is passed down along the chromosome (Lewis, Stephens), and similar action on stereoisomeric compounds (Sonneborn). It should be mentioned that many of the authors working on pseudoalleles, particularly Stadler and Lewis, do not reject the classical concept of the gene as a particulate unit of heredity. They take a middle ground by postulating that several genes in the classical sense may be united to form superimposed functional units.

Goldschmidt points out that the one gene–one enzyme theory of genic action, viz., the hypothesis that a gene's "sole activity aside from self-duplication is that of functioning in the synthesis of a particular enzyme or enzyme precursor" (Horowitz and Leupold) is a physiological correlate of the theory of the particulate gene. It is therefore not astonishing that this hypothesis is also discussed under different points of view in the symposium. Horowitz, who defends the theory, nevertheless admits that the results of a mutation in the cell must be rather complex, since "a mutation which induces a deficiency of an amino acid, for example, must secondarily affect the synthesis of virtually every protein of the cell, and an exhaustive enumeration of the end effects might well include every structure and function of the organism." This seems to imply that as a result of one mutation several different enzyme proteins might be changed. On the other hand, observations, particularly those by Bonner and by Lederberg, show that several different gene mutations may affect the formation of one and the same enzyme, as is evident particularly from the occurrence of

specific suppressor mutants. Bonner presents evidence that it is particularly the rate and time of enzyme formation which is controlled by specific genes.

A large number of papers deals with the induction of mutations. It is characteristic for the present state of genetics that only 3 of these papers deal with radiation-induced mutations, whereas the majority are concerned with chemical mutagenesis. A large number of chemicals has been used in different organisms, using different criteria for mutagenesis. It is easily understandable that the results are varied, and that it is difficult at the present time to propose a unified theory of chemical mutagenesis to cover all cases. Westergaard points out, however, that at least two and possibly three different groups of chemicals which induce different types of mutational changes by means of different mechanisms must be distinguished. In addition, it appears from material scattered throughout the volume that different genetic systems of the same organism may show different patterns of mutation under the influence of the same mutagen.

The fact that 6 papers deal with the genetic behavior of cytoplasmic components clearly indicates that the existence of self-reproducing cytoplasmic particles, causing the effects of cytoplasmic inheritance, is now generally accepted. The main problem arising from this finding concerns the interaction of genic and cytoplasmic factors, which is of fundamental importance for our understanding of the working of the cell and of developmental processes. Abundant evidence is presented that genes control the expression, activity, and in some cases the existence, of cytoplasmic structures. On the other hand, the cytoplasm may profoundly influence the activity and the behavior of the nucleus and of nuclear genes. Sonneborn presents a "closed cycle of nucleo-cytoplasmic interdetermination" for the mating type system of *Paramecium*. In this case, a characteristic of the nucleus (chromosome number) is determined by the constitution of the cytoplasm in which it lies. This constitution of the cytoplasm has, in turn been shown to be under the control of the nucleus. In addition, Ephrussi presents evidence that nuclear genes may control the frequency of mutation of cytoplasmic particles. Thus, the study of the interaction between genes and cytoplasmic factors promises to give further insight into the action of the nuclear genes in the cell.

Thirteen contributions deal specifically with the genetics of bacteria and bacteriophages. In this field, all the problems discussed with respect to other organisms are encountered, and valuable contributions have been made. But in addition, the basis of genetic mechanisms in higher animals, the chromosome theory of heredity, is not yet on as firm a basis in these organisms as it is in higher organisms, and a considerable portion of the work done in this field consequently deals with the elucidation of the basic hereditary mechanisms. The cytological basis, the behavior and structure of the bacterial nucleus, is still in doubt, since the two authors dealing with this subject, Bisset and Delamater come to profoundly different results concerning this problem. This is not astonishing in view of the minute size of the objects studied and the different techniques employed by the two workers. The problem of the bacterial nucleus and its divisional cycle is highly reminiscent of the state of protozoan nuclear cytology before the appearance of Belar's classical book, *Der Formwechsel der Protistenkerne*. The phenomenon of genetic recombination, on the other hand, appears well analyzed, both in bacteria and bacteriophages, thanks to the fundamental investigations of Lederberg and his colleagues, and of Hershey. Witkin, in a number of elegant experiments, provides evidence that mutations in bacteria are nuclear events and therefore comparable to mutations in higher organisms.

There exist, however, genetic phenomena in bacteria which have not yet been demonstrated in other organisms, and which may be of the utmost importance for our understanding of the nature of genes. Foremost amongst these is the phenomenon of bacterial transformation, the transmission of hereditary characters by means of desoxyribosenucleic acids derived from one strain to susceptible cells of another strain. New experimental data presented by Ephrussi-Taylor give evidence for the existence in the active DNA preparations of genetic systems closely resembling the systems of pseudoalleles found in the chromosomal genes of higher organisms.

It is evident from the Symposium volume that genetics at present is in a state of flux. This has the disadvantage that it is impossible right now to present a coherent and integrated picture of the gene and its properties. This state is characteristic of any science which is actively developing. New facts are discovered faster than they can be integrated into the conceptual framework of the science, and lead to the consideration of alternative ideas. It may be anticipated that genetics will soon make further progress due to further discoveries that may lead us to a deeper understanding of the fundamental properties of genetic materials, and therefore of the process of life.

REVIEWS AND BRIEF NOTICES

General Biology: Philosophy and Education..... 248
Biology: History and Biography..... 250
The Young Naturalist..... 254
Evolution..... 257
Genetics and Cytology..... 259
General and Systematic Botany..... 261
Plant Morphology..... 263
Plant Physiology..... 263
Economic Botany..... 263
General and Systematic Zoology..... 265
Economic Zoology..... 271
Animal Growth and Development..... 271
Animal Morphology..... 276
Animal Physiology..... 276
Animal Nutrition..... 279
Biophysics and General Physiology..... 279
Biochemistry..... 281
Microbiology..... 284
Parasitology..... 286
Health and Disease..... 286
Psychology and Animal Behavior..... 294
Human Biology..... 302
Biometry..... 302
De Omnibus Rebus et Quibusdam Aliis..... 303

GENERAL BIOLOGY: PHILOSOPHY AND EDUCATION

GENERAL EDUCATION IN SCIENCE.
Edited by I. Bernard Cohen and Fletcher G. Watson; with a foreword by James Bryant Conant. Harvard University Press, Cambridge. $4.00. xviii + 217 pp. 1952.

This book represents the answer to date, rather than the complete and final fulfillment, of the demand for reform in the teaching of science embodied in the famous "Harvard Report" on *General Education in a Free Society*. The 15 chapters are essentially papers presented several summers ago at the Workshop in Science in General Education held at the Harvard Summer School. The most valuable part of the book, because based on first-hand experience, is composed of the chapters written by the men who are actually teaching science courses in the general education program at Harvard or, in a few instances, at other institutions. No formal syllabi are included, but the various writers make an honest, informative effort to explain their objectives and to give, in some detail, their methods. All are endeavoring to make clear to the student the true nature and implications of science, in contrast to, let us say, information about the number of pareiopods in a crayfish. All rely to a greater or less extent on the "case method."

In the physical sciences, it is at once evident that there are wide divergences of approach in the courses offered in this general program at Harvard. This is surely as it should be, not only to capitalize on the varied experience, interests, and personalities of any given faculty, but also to encourage the experimentation that is so essential if the most worthwhile results are ultimately to be attained. One approach emphasizes the impact of science on society and makes much use of advances in transportation and the means of communication. A second approach is primarily historical and includes a great deal of what is called the "sociology of science." It relies heavily on astronomy. A third attempts to confer an understanding of the "tactics and strategy" of science, together with some knowledge of its philosophical implications and sociology, by a judicious use of the case method. The cases are not limited to material from the past. A fourth approach treats much the same material as the third, but on a deeper level of understanding and with greater emphasis on the philosophical aspects of modern physics. This course proved to be necessary for the boys who arrived in college already equipped with expert training in physics and mathematics, including in many cases some knowledge of calculus.

The treatment of the biological sciences appears to be less novel than is true for the physical sciences, in fact not too utterly different from the orthodox approach in many of the general courses long familiar to most biologists. One has the feeling that E. G. Conklin, or W. K. Brooks, or Louis Agassiz himself would have felt at home in this new program. One of the authors has suggested elsewhere that the lesser degree of change in the presentation of the biological material may well be because biology has always been obviously laden with matters of great and universal human importance. It is only necessary to mention the names of Darwin, Pasteur, and Mendel to see this. Chemists, by contrast, have more frequently been accused of filling their introductory courses with material of real concern for chemists and for chemists only.

On one issue the biologists disagree with their colleagues in the physical sciences. The latter tend to make a separation between the freshmen who intend to specialize in physics or chemistry and those who do not. The biologists are convinced that such a "segregated education . . . would perpetuate an unwholesome distinction among educated men. Unless the lesson is learned that one cannot live either without science or with science alone, the battle is lost. For this reason we have for some years assigned to our students T. H. Huxley's essay 'We Are All Scientists'." It is worth noting that this stand against segregating students who think they want to major in a science from those who think they do not, agrees with the conclusion reached at the symposium on the teaching of biology to college freshmen held at St. Louis by the Society of Systematic Zoology under the sponsorship of the National Science Foundation.

G. B. MOMENT

GENERAL BIOLOGY. *Third Edition.*

By Leslie A. Kenoyer, Henry N. Goddard, and Dwight D. Miller. Harper & Brothers, New York. $6.00. viii + 662 pp.; ill. 1953.

The previous edition of this text was favorably reviewed in these pages (*Q. R. B.*, 21: 73.1946), and this third edition is an indication of its general acceptance. Much of the text has been rewritten, new illustrations have been introduced, and a considerable rearrangement of material has been made. These changes have improved a basically sound textbook.

HENRI C. SEIBERT

AUF DEN PFADEN DES LEBENS. *Ein Biologisches Skizzenbuch.*

By Ludwig von Bertalanffy. Universum Verlagsges. M. B. H., Wien. viii + 252 pp. + 15 pl.; text ill. 1951.

A straight line is said by scientists to be the shortest distance between two points. But the acquisition of understanding is not a course between two fixed spots. The mind of man is convoluted; and the river of knowledge meanders tortuously past the hills and the plains of the unexplored. This is to say that there may be merit, if one wishes to learn the country, in avoiding the main route to the center of biological knowledge and in wandering instead through the intellectual sidepaths which skirt it.

This small book is precisely what its title indicates, a sketchbook presenting some not completely random reflections of prospects perceived while rambling down the lanes. It covers a number of scenes: instinct, growth, parasites; biological rhythm, sex determination; antibiotics, and the unity of science, to mention only a few. The sketches are brief, reasonably accurate, and pleasingly enough written. Their approach is somewhat subjective, in some cases unintentionally when the author rides a swift teleological pace, at others deliberately when he takes care to point out in so many words what his own contributions to the philosophy of biology have been. The book, which is addressed to a popular audience, will prove interesting and useful to American students who are attempting to improve their use of the German language if they are content to stroll the by-ways rather than to follow von Frisch up the high road.

JANE OPPENHEIMER

IN THE NAME OF SCIENCE.

By Martin Gardner. G. P. Putnam's Sons, New York. $4.00. x + 320 pp. 1952.

Science itself may not be a sacred cow, but there is plenty of pseudoscience to fool the unlearned and the learned alike. Martin Gardner has written a very readable and remarkably well balanced and accurate book about the entire gamut of pseudoscience, from the believers in a flat or hollow earth to those who believe in ESP and PK. Rubbing elbows with one another in these pages are patent charlatans, medical cultists, pyramidologists, believers in Atlantis and Lemuria, racists, anti-evolutionists, anti-Einsteinians, plain cranks, fancy cranks, and reputable scientists who have drifted into the fringes of the disreputable, or at least the questionable. J. B. Rhine will hardly like to see his efforts to study extra-sensory perception and psychokinesis classed with the wild imaginings of Immanuel Velikovsky or Charles Fort, nor with the fad of dianetics or the persistent faith in dowsing for water or minerals with a forked twig. Yet if Gardner is rude and journalistic in his sweeping attacks, he also possesses rather good critical judgment, and his blade is sharp.

Every scientist, for the preservation of his own good sense, should read *In the Name of Science*, and likewise everyone who is concerned with the influence of science in society—as who is not. Biologists are directed in particular to the chapters on the creators of life (Under the Microscope), on the opponents of evolution (Geology versus Genesis), on the inheritance of acquired characteristics (Lysenkoism), and on racism (Apologists for Hate). To which there may be added the medical fads (Medical Cults; Medical Quacks; Food Faddists; Throw Away Your Glasses; Eccentric Sexual Theories; Orgonomy; and Dianetics). It is somewhat startling to find phrenology and palmistry, sandwiched at the end between Korzybski and Rhine but perhaps this was done with forethought. Gardner does not deny the value of all work along unorthodox lines, and Lombroso and Sheldon find their way into the meat of the sandwich. What Gardner does try to do is to point out the similarities between most of those beyond the pale and some others at work on the borders of science: the originality and the daring that become exaggerated into paranoia, the lack of a severe critical attitude toward one's own work, the gullibility that ends by seeing what it has long hoped and expected to see.

A scientist would perhaps have written this book, if ever a scientist would think of writing it, in quite a different manner. It would be heavily documented, more cautious in statement, less vehement, less prejudiced. It would also, without question, I think, be less effective in gaining its purpose; for here is a book that scientist and non-scientist alike can read, and read with enjoyment. A bitter aperitif, it may lead to better scientific digestion.

BENTLEY GLASS

SCIENCE AND RELIGION IN AMERICAN THOUGHT. *The Impact of Naturalism.*

By Edward A. White. Stanford University Press, Stanford. $2.50. ix + 117 pp. 1952.

In his Preface, the author, who is an associate professor of history at Scripps College, states that "this book undertakes to analyze the positions of various American thinkers for whom the relationship of science and religion was a problem." The account begins with a discussion of the views of John William Draper, who wrote a *History of the Conflict of Religion and Science* in 1873. A study of Andrew Dickson White, John Fiske, and William James is followed by a more extended consideration of the views of David Starr Jordan. With a dissection of John Dewey's thought on the matter, the stage is fully set for a final consideration of the controversy between Fundamentalism and Modernism in the United States during the decade of the '20s.

The author has a decided gift for analysis, and the thoughts of the various protagonists are set forth clearly in relation to one another and to the advancing acceptance of the theory of organic evolution. The discussion of Fiske and James is particularly able; and the chapter on David Starr Jordan renders him full justice. On the other hand, the chapter on Dewey is unsympathetic. Perhaps the author is right in regarding Dewey as the outstanding cause of the modern cleavage between science and religion: "For the hiatus between science and religion in recent American thought no one bears more responsibility than John Dewey." Yet one may be pardoned for suspecting that, had there never been a John Dewey, the clash of Fundamentalism and Modernism would have held much the same course. A far more extensive study of this clash of the present era remains to be made. Nevertheless, White's thin volume is more than a fair beginning—it is indeed excellent. Today we find many persons on the side of religion and many on the side of science who are concerned about the reconciliation of these "two roads to truth." Many books are written to that end, and many things are being resaid that were said by Fiske, by William James, or by David Starr Jordan. All of us to whom this conflict is important owe a debt of gratitude to E. A. White for so ably shedding light on its history, and for so thoroughly analyzing the positions that have been taken up in the past. Much paper may be saved by taking the pains to look back at yesterday, to perceive how John William Draper, Andrew Dickson White, John Fiske, William James, David Starr Jordan, John Dewey, and undoubtedly numerous others, grappled with these problems, before one undertakes to advance a modern solution of them. In philosophy and religion, as in science itself, man can build the new only by understanding the old.

BENTLEY GLASS

FOLIA BIOLOGICA. *Kwartalnik Naukowy. Tom I, Zeszyt 1–4. Edited by Stanislaw Skowron. Panstwowe Wydawnictwo Naukowe, Warszawa.* Cena Zł. 12.00. Pp. 1–286 + 12 pl.; text ill. 1953.

This new Polish biological quarterly, which carries a frontispiece portrait of the late-lamented Jósef Wissarionowicz Stalin, contains in Volume I a total of 22 articles, 7 of which may be classed as belonging to the subject of experimental embryology, 8 as endocrinological, 2 as cytological, 4 as physiological, and 1 as ecological. All articles are written in Polish (except for 1 in Hungarian); but all are provided with summaries in both Russian and English. The paper is unfortunately rather poor, and the halftones are not well reproduced. It is also regrettable that the headings of tables are not bilingual or trilingual, since much more might be gained from the quantitative data by those who do not read Polish, were they only able to interpret the tables.

It is of some interest that a single paper is devoted to a study of longevity in *Drosophila melanogaster* males and females, as affected by copulation and oviposition. It has been rather widely assumed that, following the ascendancy of Lysenko in Soviet Russia, scientific studies of the fruit-fly were to be regarded, in all countries behind the Iron Curtain, as impractical researches of no possible social importance. Is this a straw in the wind?

BENTLEY GLASS

BIOLOGY: HISTORY AND BIOGRAPHY

BIOLOGISCHE GRUNDPROBLEME UND IHRE MEISTER. *Second Edition. By W. v. Buddenbrock. Naturwissenschaftlicher Verlag, Berlin-Nikolassee.* DM 10.80. vi + 161 pp. + 8 pl. 1951.

"Fundamental Problems of Biology and Their Masters" first appeared in 1929. The book has been reprinted without any changes in order to keep the cost low and because, as the author explains, present library conditions in Germany would have made extensive studies of the literature impossible. The work is divided into the following main sections (and subdivisions): Origin of Life (spontaneous generation, fertilization, ontogeny); Organization of Life (cellular theory, the problem of organic teleology); Relation of Life to the Totality of Nature (the principle of energy and life, chemistry of life); preservation and Evolution of Life (heredity, phylogeny). As title and disposition indicate, the book deals with the history of biological problems, and while they are presented with reference to their main proponents, biography plays a minor role. Moreover, main emphasis is placed on the discussions that prevailed in Germany in the second half of the 19th century, the development during the first decades of the present century being hinted at rather than described. This may have been justifiable when the book first appeared. However, the absence of changes or additions gives

the reprint a very "dated" character. The neglect of more recent discoveries appears most startling in the last section, which has little bearing on the present status of the problems discussed. As a result, the book will appeal chiefly to readers with strong historical interests. The excellent reproductions of portraits of Oscar Hertwig, K. E. v. Baer, Roux, Buetschli, Weismann, Mendel, Darwin, and Haeckel are a very attractive feature of the book.

OWSEI TEMKIN

A BIBLIOGRAPHY OF THE WRITINGS OF DR. WILLIAM HARVEY 1578–1657. *Second Edition.*

By Geoffrey Keynes. Cambridge University Press, New York. $10.00. xiv + 79 pp. + 8 pl. 1953.

Geoffrey Keynes needs no introduction. His personalized bibliographies of John Donne, John Evelyn, William Blake, Sir Thomas Browne, Jane Austen, John Ray, and William Harvey are known and appreciated by scholar and student alike. Harvey has been the subject of four books by Keynes: a bibliography of his writings (1928), an annotated reprinting of Harvey's two anatomical works (1928), a study of his portraiture (1944), and an essay on his personality (1950) (*Q. R. B.*, 26: 196. 1951). The work under review is the second edition of his bibliography, which was initially published on the occasion of the three hundredth anniversary of the appearance of the *De Motu Cordis*, Harvey's first book. It is noteworthy that the first edition of the bibliography in 300 copies was sold out in a matter of a few weeks.

Personalized bibliography, of which Keynes is today the foremost advocate, reveals more about a man than the conventional biography—it provides details on when and how he began to write, what he wrote, both published and unpublished, what prompted him to undertake each work, and what each encompassed. This bibliography of Harvey is an outstanding example of such an analysis and provides a real basis for comprehending the man and his endeavors. William Harvey wrote only three books during his life, the *De Motu Cordis* (1628), the *De Circulatione Sanguinis* (1649) and the *De Generatione Animalium* (1651). These are critically characterized and described bibliographically by Keynes in all printings both contemporary and modern. In addition the *Opera Omnia* and a number of minor miscellaneous writings published posthumously are given. The majority of Harvey's manuscripts are believed to have been destroyed in the fire of London, 1666; those that have survived are enumerated in this work. A valuable index of recorded copies of Harvey's printed writings has also been appended by the author. A number of illustrations of portraits, plates, title-pages and manuscripts complement the text and collations.

The second edition has been revised and reset but preserves the excellent typographical style of the earlier edition in most respects. New entries have been added, some errors corrected, and the list of recorded copies, especially of the *De Motu Cordis*, supplemented; but the changes have not been extensive. A new frontispiece is used, that of the earliest known portrait of Harvey, which shows him as he was at about the time of the promulgation of his doctrine of the circulation of blood. Another representation of Harvey in old age has been introduced, and a new plate of a manuscript note has been made.

Little can be added to the many deserved plaudits already accorded the first edition of this profound study. It is in its welcome new printing of 750 copies a happy combination of the scholarship and humanism so characteristic of Geoffrey Keynes. He has provided us with the definitive bibliography of the works of Harvey, a fitting tribute to "one of the greatest of all figures in the history of medicine and the biological sciences."

HERBERT S. KLICKSTEIN

NEW GREEN WORLD.

By Josephine Herbst. Hastings House, New York. $4.00. x + 272 pp. + 8 pl. 1954.

This is a readable, sensitive account which centers upon the lives of John Bartram, his son William, and their British correspondent, life-long friend, and advisor, Peter Collinson. Other comtemporary naturalists, such as Peter Kalm and Alexander Wilson, appear but briefly in the course of the book. Through its pages there is recreated the virgin wilderness from the Great Lakes to Florida, teeming with a bewildering abundance of wildlife and scores of plants unseen by scientists until gathered by the Bartrams, carefully tended in their gardens on the Schuylkill River, and packed off to Collinson for wealthy patrons in eighteneth century England. Yet it is more than a treatment of contributions to the natural history of early America, for the author considers the sharply contrasting philosophies of John and of his gifted son, William. The father is depicted as a strong-willed, self-reliant man with tremendous energy and desire to press on in search of novelties to delight the patrons solicited by Collinson. William, on the other hand, is characterized as a sensitive, rather idealistic youth, who struggled for years through repeated failure to find himself under his father's patient but strong-willed influence. While John devoted much of his lifetime to an unceasing search for new plants and to matter-of-fact diaries of his travels, William contributed beautiful drawings and one magnificent chronicle of his single extensive journey by himself. With keen insight indeed, the author portrays the psychological problems besetting William through the years prior to his expedition to Florida. Whereas John doubtless contributed more to the world of plants per se, William's talented and de-

scriptive prose attracted the attention of many British and French literati. This widespread impact of William's *Travels* upon the literary world of his day is carefully traced by the author.

As a scientific treatise, this volume falls short of being a critical appraisal of the contributions of the Bartrams to natural history. In fact, the author makes no attempt to annotate the scientific nomenclature or common names of various plants and animals illustrated in the selected samples of drawings by William. Nevertheless, Miss Herbst has included a mention of many of the important discoveries of the Bartrams. Her charming prose, lively sense of humor, and penetrating insight into the lives of these men make this book delightful and informative reading.

WILLIAM B. DREW

SERGEI N. WINOGRADSKY, *His Life and Work. The Story of a Great Bacteriologist.*

By Selman A. Waksman. Rutgers University Press, New Brunswick. $4.00. xvi + 150 pp. + 5 pl. 1953.

On February 24, 1953, at the age of 96, there passed away a man who was perhaps the only remaining link with the heroic formative period of microbiology. Not only was he a link with the period of Pasteur, De Barry, Cohn, and Koch, during which were laid the foundations of microbiology, but he himself was one of the founders, equal in standing and reputation with the others. His major contributions had been made well before the turn of the century. To him is due the recognition of the unique properties of the autotrophic organisms, the sulfur and iron bacteria, and those responsible for nitrification. It would appear that the work leading up to these discoveries was largely his own. He was not surrounded by assistants, and when about 1900 he became an administrator his scientific productivity stopped. It ceased for more than 20 years, for a diversity of reasons, and then, in what for some might have been a period of retirement, it flowered again in perhaps a frailer, less conspicuous form.

Waksman has performed a most useful service in bringing together details of the life and work of Winogradsky, with whom in his later years he was in frequent touch. One of the penalties of outliving one's contemporaries is that a modest man may well be forgotten. In the twilight of his life Winogradsky was not well known even among microbiologists, other perhaps than those themselves interested in soil microbiology or physiology. To others his was a name recalled only imperfectly as one of the founders of the science.

To the few who read his later papers, published mostly in the *Annales Pasteur*, it was clear that Winogradsky was developing a concept of soil microbiology that differed considerably from conventional views in this field. It is indeed a calamity that he seemed to have lacked either interest in agronomic problems or a knowledge of their complexity, and that therefore he did not push his highly original concept of soil microbiology to the point that might have gained for it a greater degree of acceptance.

This readable account of his career puts on record many details of his life and professional career. It is perhaps not a biography in the conventional sense because it leaves much unsaid that should be said. The reader is assumed to know the value of his contributions, to recognize the novelty of his ideas when they were advanced, and to understand the great part which this man played in building the science of microbiology. Perhaps Waksman may later be willing to prepare the sort of biography of Winogradsky that his eminent student, René Dubos, accomplished so well for Pasteur. In the meantime, this little book will preserve much that might too readily have become lost.

A. G. NORMAN

ERWIN FRINK SMITH. *A Story of North American Plant Pathology. Mem. Amer. phil. Soc., Vol. 31.*

By Andrew Denny Rodgers III. American Philosophical Society, Philadelphia. $5.00. x + 675 pp. + 2 pl. 1952.

This book is far more than a simple biography of a great scientist, it is also the history of a science, that of plant pathology, from its earlier, feeble beginnings in the United States in the 1880's through its development for over forty years, from the entry of Erwin Frink Smith into the United States Department of Agriculture in 1886 until his death in 1927. The biographer does not ascribe to E. F. Smith the whole of the marvelous development of this branch of science but follows both in their growth.

Smith was the son of a tanner in Gilbert's Mills New York, where he was born in 1854, and lived until 1870, when his father purchased a farm in Clinton County, Michigan, to which the family removed. In his old home he attended the public school and came under the influence of his teacher, Miss Ida Holmes, a cultured woman who saw in the boy the promise of great ability. She lent him books by the best American and British authors, as well as magazines, among them the *Atlantic Monthly*. Thus at an early date he acquired the knowledge and love for good literature and that ability to write clearly which clung to him his whole life long. He wandered in the woods and learned to know the animals and plants. Very early he began to appreciate beauty, whether in flowers, insects, or sunsets, and this expressed itself in the form of poetry later in his life. He soon began to keep a diary in which he recorded not merely his actions of the day but also his thoughts and emotions and plans for the future.

In his new home in Michigan the 16-year-old boy was prevented by the necessary work on a stony and

not too good a farm from continuing his public school studies. He had a charm about him that attracted others to take interest. In 1870 he had obtained a copy of Gray's *Field, Garden and Forest Botany*. This he studied assiduously as he collected plants in his wanderings through the woods and swamps and by the river-side. This love for botany brought him into contact with Charles F. Wheeler, the postmaster and druggist at nearby Hubbardston. The latter, too, was a lover of botany, and he helped the boy in his studies with plants. He was a good French scholar and taught Smith this language, in which he eventually gained great proficiency. The boy studied at home, completing almost all of the required grade-school work that way. Finally, at the age of 22 years, in 1876, he entered the High School at Ionia.

In order to finance himself while at high school the young man Smith worked nights as a prison guard at the Michigan State Reformatory at Ionia. In any spare hours he and Wheeler continued joint work on a *Catalogue of the Phaenogamous and Vascular Cryptogamous Plants of Michigan, Indigenous, Naturalized and Adventive*, which eventually was published in 1881. He collected and prepared sets of specimens from Michigan which he exchanged with botanists throughout North America and even in Europe. He made the acquaintance of Dr. Wm. J. Beal, of the Michigan State Agricultural College, at Lansing, and of a young horticulturist, Liberty Hyde Bailey, and of Professor Volney M. Spalding, of the University of Michigan at Ann Arbor. These friends, together with Wheeler encouraged him to plan to go to the University to complete his education, but although he graduated from the Ionia High School in 1880 it was not until the autumn of 1885 that he finally entered the University with several years' advanced credits. In the intervening years he took one summer term of work in botany under Dr. Beal at the Agricultural College. He became a correspondence clerk for the Michigan State Board of Health. In this situation he prepared some of the reports and wrote articles based on his reading of the various health board reports and medical journals of other states and especially of Europe. Added to his proficiency in French he soon developed the ability to read German, the study of which language he began in 1884.

At the University Smith's work was largely in botany, under Professor Spalding. He graduated with honors on July 1, 1886. He had hoped to become a professor of natural science at some college, but now, with his greater training in the field of botany, he accepted a 6-months' appointment in the fall of that year in the United States Department of Agriculture, where his work was directed toward plant pathology. The appointment became a permanent one and terminated only with his death in March, 1927.

At first he was a sort of handyman to whom were referred specimens of diseased plants so that letters might be answered. Also he wrote reviews of the foreign literature on plant diseases. Very early he received as his major assignment the study of the disease of the peach known as "yellows." This involved much field work, especially in Delaware, Maryland, and Michigan, and occupied the major portion of his time and energies from 1887 to 1894. He was able to prove that it was a communicable disease, but could not discover or bring into culture any organism responsible for the trouble. It was very many years later that the causal agent was discovered to be a virus.

More and more he became interested in plant diseases induced by bacteria. The possibilities of such diseases were for long doubted among the bacteriologists and plant pathologists of Europe, in spite of the fact that "fire blight" of pears and apples had been shown to be bacterial in nature by 1880, a matter more fully confirmed a few years later by Arthur. Between 1898 and 1900 Smith published in German, in a German periodical, a series of fully documented articles on bacteria in relation to plant diseases, which brought about even in Germany the recognition of bacteria as the effective cause of many plant diseases. From 1894 to 1910, aside from his bacteriological work, he was interested in the diseases of plants due to soil-borne species of *Fusarium*. Under his guidance W. A. Orton bred strains of watermelon and of cotton resistant to these fungi.

His discovery and study of undescribed plant diseases due to bacteria and of similar diseases previously reported by others led Smith to begin the preparation of a series of books entitled *Bacteria in Relation to Plant Diseases*, in which it was intended to describe carefully and fully most of the several hundred such diseases for a large proportion of which he had determined the causal organisms. Of this treatise three volumes appeared respectively in 1905, 1911, and 1914. Manuscripts and notes for several subsequent volumes were in various degrees of completion at the time of his death in 1927. Although he hesitated, because he knew that the labor would consume much time that he wanted to devote to his magnum opus, he yielded to the importunities of his friends and of other students of the subject and prepared a book entitled *An Introduction to Bacterial Diseases of Plants*, which appeared in 1920. This described in detail the methods of research on such diseases and gave directions for the study of 14 of them. He added as Part V a chapter on General Observations intended for students, and revealing the manner of studying that he employed and his intense devotion to honesty of mind and purpose, traits which led to the outstanding thoroughness of his work.

In 1907 Smith, with C. O. Townsend as coauthor, published his first paper on A Plant Tumor of Bacterial Origin, the beginning of a long series of contributions reporting his investigations of the plant disease known as "crown gall." The similarity of these galls to cancer in animals impressed him more and more, and the greater part of his investigational work became

directed into this field. Naturally this aroused the interest of students of animal cancer. Smith finally came to the point where he called crown gall "plant cancer." In 1924 he was elected to the presidency of the American Association for Cancer Research.

E. F. Smith made three rather extended trips to Europe, visiting the botanical and plant pathological institutes and becoming acquainted with the men who were doing the leading work in those positions. In his last visit he spent much time visiting the institutes for cancer research and was received enthusiastically by their staffs. Smith's influence on North American plant pathology was tremendous. As head, for many years, of the Laboratory of Plant Pathology of the U. S. Department of Agriculture, he led groups of eager students who formed for many years the core of that science in America. The history of American plant pathology cannot be appreciated properly without recognizing the relationship of its progress to the inspiration of Erwin F. Smith.

Smith married twice. His first marriage was in 1893, and his wife died in 1906. His second marriage occurred in 1914, and this second wife survived him. Both women were cultured and gifted, and were of great aid and inspiration to him. Smith's health remained good until about a month before his death, when his heart gave out. He was at his laboratory until about a week before he passed away. His death was mourned by the plant pathologists of America and Europe, as well as by students of cancer and other fields who had experienced the opportunity of becoming acquainted with him. Truly it was a great man who passed away.

ERNST A. BESSEY

THE YOUNG NATURALIST

ROBINS IN THE GARDEN.

By Olive L. Earle, illustrated by the author. William Morrow & Company, New York. $2.00. 64 pp.; ill. 1953.

The illustrations alone would make this book worth while—they are charming black-and-white drawings, full of life and expression but not in the least sentimental. Combined with a story which is certainly true to life in its details, and perhaps even as a continuous account of one robin family's summer, they make a wholly admirable book. The large type indicates that it is intended for children of seven or more, who could read it for themselves; but it is worth mentioning that it was also appreciated heartily by my four-year-old.

EILEEN SUTTON GERSH

ECOLOGY AND NATURAL HISTORY

LA MER.

Under the direction of V. Romanovsky, Claude Francis-Boeuf, and Jacques Bourcart, in collaboration with P. Bohé, J. Y. Cousteau, Jean Feuga, M. Guierre, and J. Peytel. Librairie Larousse, Paris. 5,200 fr. 503 pp. + 16 pl.; text ill. 1953.

A beautiful book such as this speaks for itself, and it is a poor soul indeed who cannot admire it as a splendid example of a great publishing tradition. But it is more than that, it is also a monument of popular science by expert practitioners of that sceince. This combination of elegant printing and authoritative popularization is characteristically European, and as far as this particular subject is concerned, characteristically French. Indeed, this volume is the successor to a similar one published some forty years ago by the same publisher. For this reason, it is instructive to compare the contents of these two volumes, separated by two wars and other political vicissitudes, to say nothing of a great increase in knowledge.

In the first place, the printing processes are greatly improved, especially those of color reproduction. The new book is almost 200 pages longer, but virtually all of the old book has been discarded. There have been some interesting changes of emphasis in the chapters dealing with non-scientific aspects of the sea: whereas there were 26 pages about sailing ships in 1912, there are only 9 in 1953, and modern navies have been pruned from 27 to 18 pages. Surprisingly enough, an entirely new chapter has been added, on sea monsters, legends, and the like. To the turn to science, the new diving methods are described by Captain Cousteau, with some now familiar color plates (but much larger and more attractively reproduced than in other books or magazines). The slim 3 pages on the economic use of sea water in the older book have been expanded to 19 in this new version. While the replacement of the old chapter on marine biological stations by a slightly shorter one of the history of oceanography is indicative of the change of emphasis in ou study of the sea, there are nevertheless some 60 pages (counting illustrations and all) devoted to marine biology, as compared with only 17 in the old book. The animals of the sea, right up to the preliminary results of the Galathaea, receive their full share of attention.

Taken as a whole, this is a book designed to be read by people who want to be informed as well as entertained, and written in a style that puts to shame the purple lapses of a well-known weekly magazine series in this country. The fault that we seldom do as well as this lies in ourselves, for too often we leave this sort of thing up to the journalists. In their effort to do all the work for their readers, they tend to leave unsaid what should be said, and imply too much in their search for fine phrases.

JOEL W. HEDGPETH

GRUNDZÜGE DER ZOOZÖNOLOGIE. *A zoocönológia alapjai.*

By J. Balogh. Hungarian Academy of Science, Budapest (sold by Kultura, Buch und Zeitungs Aussenhandels, Sztalin ut 21, Budapest). $5.00. 248 pp. 1953.

This work by a member of the University of Budapest faculty summarizes Hungarian ecological research. It has two portions, one in Hungarian, pp. 1–144, (not seen), containing tables and plates which have German titles; and a German summary, pp. 145–248. The German portion examined has four parts. The first deals with the units and categories of ecology and contains definitions for the numerous terms used. The second is an analysis of the environment. The third, entitled Produktions Biologie, discusses energy relationships, food chains, and pyramids. The final portion on field work contains quantitative collecting methods and methods to determine densities of animals. An 11-page bibliography has references to mostly Hungarian and other European publications, although some American books and papers have apparently been examined.

H. W. Levi

Parasitism and Symbiosis.

By Maurice Caullery; translated by Averil M. Lysaght. Sidgwick & Jackson, London. $5.50. xii + 340 pp.; ill. 1952.

Le Parasitisme et la Symbiose. *2nd Edition. Encyclopédie Scientifique, Bibliothèque de Biologie Générale.*

By Maurice Caullery. G. Doin & Cie., Paris. 1,250 fr. (paper). 358 pp.; ill. 1950.

In this valuable contribution, first published in French in 1920, Maurice Caullery discusses the two-species partnerships which we may classify as commensal, parasitic, or symbiotic. Introducing the subject with a consideration of the widespread commensal associations in the sea, he progresses through terrestrial commensal partnerships to a general consideration of parasitism in each invertebrate group that possesses important representatives with this habit. In 3 chapters, problems dealing with adaptive modifications in reproduction, host specificity and infestation, and the reciprocal reactions of parasite and host are discussed. The volume concludes with 2 chapters on symbioses between animals and plants and within the plant kingdom itself.

Within my own limited experience, it would seem that the study of associations has lagged behind other fields in the life-sciences. Even the most recent published works in parasitology have over-emphasized the descriptive aspects and have been far from outstanding in their discussion of physiology, behavior, and evolutionary theory beyond that dependent on morphology. Caullery's work lets a clear draft of the modern experimental attitude into a field somewhat stifled by the tradition for the descriptive.

At the first appearance of *Parasitism and Symbiosis*, with its challenging approach to the study of associations via physiology and behavior, I was so naive as to express my compliments to Prof. Caullery in correspondence, as to a contemporary rather than an "elder statesman" in his eighth decade. Such is the modern tone of this volume that it might easily be thought to be that of a young man. Caullery wastes little time in the so frequent yet so fruitless effort of many writers to establish, totally without experimental proof, whether a given partnership is commensal, symbiotic, or parasitic. He says: "Commensalism, parasitism and symbiosis are only categories created by us and as soon as they are thoroughly analyzed it is impossible to delimit them." In discussing a specific relationship that of algae and fungi in lichens, he adds the generalization: "On ridding ourselves of verbal phantoms, we find the question is really one of analyzing, by precise experiments, the relations (of the alga and fungus), and of careful comparison of their behavior in an isolated state and in association." Thus he establishes the only criteria whereby the economics of such associations can be determined.

This book is a worthy successor to its predecessors in the Sidgwick and Jackson series edited by Julian Huxley and Munro Fox. Albeit Caullery admits the work to be far from all-inclusive—he avoids as beyond its scope the consideration of parasitic bacteria—the omission of much descriptive detail is an advantage in that it allows the student to concentrate on principle. One would be hard put to it to design a text better suited to the parasitology course which is specifically planned for the undergraduate zoology or general biology major. Any omissions in detail, which may be easily compensated for in lecture, are in my opinion unimportant compared to the stimulating modernism of Caullery's approach. The important note struck throughout this significant work sounds again in his own words on the last page:

"The associations which we find in the different forms of commensalism, parasitism and symbiosis involve in the participating organisms functional activities and special developments that we do not see in free-living forms. From this arise multiple problems, not only morphological in character but also, and perhaps principally, physiological, problems of extreme complexity that we are only beginning to perceive and touch upon, and of which the interest cannot be exaggerated. Although points of view will inevitably change, the subject of this book will long remain topical in biology."

Demorest Davenport

Structure et Physiologie des Sociétés Animales. *Colloques Internationaux du Centre National de la Recherche Scientifique, XXXIV.*

Edited by Pierre-P. Grassé. Centre National de la Recherche Scientifique, Paris. 2,500 fr. (paper). 359 pp. + 18 pl.; text ill. 1952.

In 1950 a group of scientists was brought together by the Centre National and the Rockefeller Foundation to exchange ideas about animal societies. The four objectives were: (1) to discuss the origin and scope of animal sociology; (2) to summarize information about means of interaction and communication among individuals; (3) to consider the homeostatic mechanisms of a society; and (4) to interpret a society in terms of an organism. A series of 22 papers by 18 authors considers these problems among invertebrates as well as vertebrates.

The first group of papers (by Grassé, LeMasne, and Boulière) classifies the types of societies found among animals. A set of 3 papers (by Chauvin and Soulairac) considers the effect of the group on the individual. Then the theme shifts to the topic of polymorphism in insects (4 chapters by Noirot, Chauvin, Bernard, and Deleurance). The problems of dominance and territory are elaborated in 6 chapters (by Allee, Pardi, Boulière, Baerends, Darling, and Carpenter). The final group of 6 chapters attempts to outline the social coordination and regulations that suggest the concept of a superorganism. These final papers were presented by Schneirla, von Frisch, Rouband, Hediger, Grassé, and Emerson.

The papers are essentially reviews of each author's previous work and thus form an admirable summary of various aspects of societies (and are also practically impossible to abstract). However, the book as a whole lacks integration and coordination. The 3-page sum mary merely outlines each chapter without describing principles. Indeed, the whole effort lacks the integrative and regulatory mechanisms that are being discussed in the animal societies. Presumably the authors were able to integrate their ideas in informal meetings, but the reader does not get the benefit of any such results. Why, I wonder, was there no discussion of the complicated societies of the most abundant mammal, *Homo sapiens*?

DAVID E. DAVIS

BIOLOGICAL CONSERVATION *with Particular Emphasis on Wildlife.*

By John D. Black. The Blakiston Company, New York and Toronto. $5.00. xiv + 328 pp.; ill. 1954.

This is a well planned, lucid, introductory textbook for wildlife and conservation courses. Wildlife, it should be mentioned, includes all sorts of vertebrates, from fish up, and a few invertebrates. The midcontinental view of the author (who is from Missouri) is evident in his emphasis on pond and lowland stream fishes (it may be true that trout have been overemphasized, but not in mountain streams where no other game fish can live), his failure to discuss salt-marsh problems, and his omission of any discussion of wildlife conservation as related to range problems. He may err on the side of the angels in expressing his opposition to multiple purpose projects, but the first impression gained by an immature reader may be that he depends too much on invective in expressing this bias. There are two useful appendices, an annotated bibliography of books on wildlife, and a guide to educational films. Although the author makes no claim for completeness for his bibliography, it is odd to find that not a single flora, plant ecology textbook, or insect manual has been listed, and that the only reference applying to rangelands is the Department of Agriculture Yearbook on *Grass*.

JOEL W. HEDGPETH

FLAMINGO HUNT.

By Paul A. Zahl; illustrated by Fritz Kredel. The Bobbs-Merrill Company, Indianapolis and New York. $3.50. 270 pp. 1952.

Zahl has written a delightfully descriptive adventure story of three expeditions into the lake areas of the Bahamas to study the status of flamingo rookeries there. From far larger numbers the birds had been dwindling away, and the need for protection was evident if they were not to disappear altogether. Bahamian residents in outlying areas were hungry, since the land and sea could not support them in the way to which they had become accustomed prior to destruction of the sponge-fishing industry by a disease; such people sought the eggs and meaty birds as food. Thoughtless aviators buzzed the nesting flocks to see the swirl of pink birds—and left behind them trampled eggs or chicks. The oil industry prospected the area. But Zahl's work culminated in a token leg-banding of three birds, in appointment by the Bahamian government of a warden for the Andros island nesting areas, and in further sanctuaries under the asupices of the Audubon Society. The whole subject is treated with sufficient humor to make it excellent reading.

LORUS J. & MARGERY J. MILNE

FLORIDA BIRD SONGS.

Recorded in their natural habitats by the Staff of the Laboratory of Ornithology at Cornell University, with the assistance of David G. Allen, Byrl J. Kellogg, and James T. Tanner; the Barred Owl recorded by Jerry and Norma Stillwell; produced by P. P. Kellogg and A. A. Allen for the Albert R. Brand Bird Song Foundation, Laboratory of Ornithology, Cornell University. Comstock Publishing Associates, a Division of the

Cornell University Press, Ithaca. $2.50. 78 RPM.; vinylite.

THE MOCKINGBIRD SINGS. *The Natural Song of the Mockingbird, and his Imitations of the Songs of Over Thirty Other Birds.*

Prepared from recordings made for The Massachusetts Audubon Society and supervised by C. Russell Mason; produced by P. P. Kellogg and A. A. Allen of The Laboratory of Ornithology, Dept. of Conservation, Cornell University, for The Albert R. Brand Bird Song Foundation. Cornell University Records, A Division of Cornell University Press, Ithaca. $2.50. 78 RPM.; unbreakable plastic.

WESTERN BIRD SONGS. *The Voices of 10 Familiar Songbirds of Western North America, Recorded in their Native Habitats.*

Recorded by William R. Fish; produced by P. P. Kellogg and A. A. Allen for The Albert R. Brand Bird Song Foundation. Cornell University Records, A Division of Cornell University Press, Ithaca. $2.50. 78 RPM.; unbreakable plastic.

These three records are among the most recent additions to the outstanding collection of recordings of American bird songs in their native habitats now being made by the Cornell Ornithology Laboratory and the Albert R. Brand Bird Song Foundation. They are incomparable not merely because there exist no others of merit—which I suppose is true—but much more because of the infinite pains that have gone into capturing the songs throughout the full frequency range in proper balance. The recording of bird songs has now progressed far beyond the stage where mere audibility and recognizability were enough. Played on high fidelity equipment, these records sound like the real birds close at hand. The sole flaw I have found is that even at a reasonable amplification—judged by the remainder of the song—staccato, throbbing notes tend to come out as resonating thumps. This is apparently due to some characteristic of the parabolic sound-reflectors used to concentrate and record the bird voices from a reasonable distance.

The record of Florida birds includes, on separate bands so that they may be played individually, the songs of the Mockingbird, Cardinal, Florida Wren, Blue Jay, and Boat-tailed Grackle (Side 1); and those of the Ivory-billed Woodpecker, Florida Sandhill Crane, Limpkin, Barred Owl, and Chuck-will's-widow (Side 2). Although some of these are common in other parts of the country and some are included in other records of the Cornell series, the Florida Wren and the rare Ivory-billed Woodpecker are special features of this disk.

The mockingbird record features two particularly talented individual songsters, who between them provide (1) the distinctive song of the species, and (2) imitations of 32 other birds. Many of these are identified for the listener by C. Russell Mason, Director of the Massachusetts Audubon Society. American bird-lovers will prize this record; but it should become even more of a treasure to foreign ornithologists who have never had the opportunity to hear in person the amazing versatility of this king of songsters. (As I write, the mocking-birds in my own yard are making such an incessant noise that it is quite superfluous to play the record.)

The record of Western birds includes, on separate bands, the songs of the House Finch, Western Meadowlark, Bewick Wren, Black-headed Grosbeak, and Spotted Towhee (Side 1); and of the Wren Tit, Lazuli Bunting, Western Kingbird, Gambel's White-crowned Sparrow, and Bullock Oriole (Side 2). As in all of these records, each birdsong is introduced by an announcement. In repeated listening, many of the longer, more elaborate announcements become tiresome. The true birdlover and ornithologist would be quite satisfied with the briefest identification.

BENTLEY GLASS

NATURAL HISTORY OF THE PALLID BAT, ANTROZOUS PALLIDUS (LECONTE). *Proc. Calif. Acad. Sci., 4th Ser., Vol. 28, No. 4.*

By Robert T. Orr. California Academy of Sciences, San Francisco. $2.00 (paper). Pp. 165–246; ill. 1954.

EVOLUTION

THE PLANETS. *Their Origin and Development.*

By Harold C. Urey. Yale University Press, New Haven; Geoffrey Cumberlege, Oxford University Press, London. $5.00. xviii + 245 pp. + folding map.; ill. 1952.

Urey's comprehensive and original treatise on the primeval states of the members of the solar system provides the necessary physical and chemical background for any biologist who wishes to speculate about the origin of life. In particular, the chapter on Early Chemical Conditions needs to be read in this connection. It is significant that Urey, like Oparin, believes that one must postulate that life originated under reducing conditions, and not under oxidizing conditions. These reducing conditions may possibly have lasted, Urey suggests, to a time as recent as 800 million years ago, whereas there was a span of time nearer 2 billion years from the beginning to the appearance of photosynthesis.

BENTLEY GLASS

HISTORY OF THE PRIMATES. *An Introduction to the Study of Fossil Man. Third Edition.*

By W. E. Le Gros Clark. The Trustees of The British Museum (Natural History), London. 4s. (paper). iv + 1 pl. + 117 pp.; text ill. 1953.

Brought thoroughly up to date by a truly great authority, this small guide is a far better introduction to the primates than many weightier volumes. A careful weighing of the evidence regarding the Australopithecines' closeness to man, and a properly dubious attitude toward Piltdown Man, which was not known at the time of writing to be a fake, sufficiently exemplify the author's scientific breadth and caution. This small book—would there were many like it—might serve admirably to supplement and correct the average college textbooks in biology, zoology, comparative anatomy, and evolution.

BENTLEY GLASS

THE MIOCENE LEMUROIDS OF EAST AFRICA. *Fossil Mammals of Africa No. 5.*

By W. E. Le Gros Clark and D. P. Thomas. British Museum (Natural History), London. 12s. 6d. (paper) 20 pp. + 3 pl.; text ill. 1952.

This monograph, the fifth of a group describing fossil mammals from Africa, presents an account of prosimians recovered between 1947 and 1950 by the British-Kenya Miocene Expedition. The material was found in the same localities as the now well-known specimens of *Proconsul* and *Limnopithecus* which were described in the first and third monographs of the series.

Fifteen jaws and their contained teeth have been assigned to the species *dorae, robustus,* and *minor* of the genus *Progalago,* which was first diagnosed 11 years ago by MacInnes. Part of the calvarium and base of a skull, together with an almost complete endocranial cast, are also assinged to this type. The authors note that in the "total morphological pattern" presented by the dentition, skull, and endocranial cast *Progalago* approximates closely to the modern genus *Galago* and that it presents primitive features which ". . . conform reasonably well with theoretical postulates for an early Miocene member of the Galaginae." They deduce that the new material provides no morphological argument against MacInnes' view that *Progalago* was ancestral to the modern *Galago.*

The account concludes with a discussion of some recent studies of Eocene prosimians, and the authors advance the thesis that the lorisiformes ". . . may have been derived from one of the groups of Eocene lemurs." They point out, however, that further paleontological material will be necessary before this question can be finally answered. When such material is forthcoming, we shall be in a better position than we now are, to assess the phylogeny of the Galaginae.

ERIC H. ASHTON

THE MIOCENE AND PLEISTOCENE LAGOMORPHA OF EAST AFRICA. *Fossil Mammals of Africa No. 6.*

THE MIOCENE HYRACOIDS OF EAST AFRICA. *Fossil Mammals of Africa No. 7.*

(6) By D. G. MacInnes. (7) By T. Whitworth. British Museum (Natural History), London. (6) 10s. (paper); (7) £1. 5s. (paper). (6) 30 pp. + 1 pl.; text ill. (7) iv + 58 pp. + 7 pl.; text ill. 1953; 1954.

GIGANTOPITHECUS BLACKI VON KOENIGSWALD, A GIANT FOSSIL HOMINOID FROM THE PLEISTOCENE OF SOUTHERN CHINA. *Anthrop. Pap. Amer. Mus., Vol. 43, Part 4.*

By G. H. R. von Koenigswald. American Museum of Natural History, New York. 50 cents (paper). Pp. 295–325 + 2 pl.; text ill. 1952.

Four molar teeth of a giant hominoid were recovered by von Koenigswald from Chinese drugstores in 1935 and 1939, and were assigned to the genus *Gigantopithecus.* An upper incisor and canine are regarded as possible additional representatives of this type. In 1945, Weidenreich described casts of some of these teeth, the original specimens being inaccessible owing to the war. The present monograph furnishes a new account of this primate, based on the discoverer's own study of the original specimens, and presents his interpretation of their phylogenetic significance.

The teeth were mixed with those of members of a fauna which von Koenigswald regards as characteristic of a period of climatic disturbance, and he suggests that they probably date from the beginning of the second glacial period. He notes that this view is consonant with the presence in the fauna of a "*Sinanthropus* type of man," which he assigns to the new species *Sinanthropus officinalis.*

Von Koenigswald emphasizes features of the main cusps, the presence of accessory cusps, the "flat" type of wear, the shape of the pulp cavity, and the degree of hypsodonty of the molar teeth, and concludes that *Gigantopithecus* should be placed in the hominoid rather than in the anthropoid group of the Hominoidea. He does, however, point to some features of the dental morphology which he regards as specialized, and advances the view that these, coupled with the relatively young geological age, preclude *Gigantopithecus* from the ancestry of modern man. This proviso should be borne in mind, particularly in view of our relative ignorance of the variability of these dental features of living men and apes, when considering the assignation of the specimens.

ERIC H. ASHTON

EARLY DEVONIAN FISHES FROM UTAH. *Part II. Heterostraci. Fieldiana, Geol., Vol. 11, No. 7.*

By Robert H. Denison. Chicago Natural History

Museum, Chicago. $1.25 (paper). Pp. 291–355; ill. 1953.

A CONIFEROUS PETRIFIED FOREST IN PATAGONIA. *Bull. Brit. Mus. (Nat. Hist.), Geol., Vol. 2, No. 2.*

By Mary Gordon Calder. The British Museum (Natural History), London. 12s. (paper). Pp. 97–138 + 7 pl.; text ill. 1953.

SOME UPPER CRETACEOUS AND EOCENE FRUITS FROM EGYPT. *Bull. Brit. Mus. (Nat. Hist.), Geol., Vol. 2, No. 4.*

By Marjorie E. J. Chandler. The British Museum (Natural History), London. 16s. (paper). Pp. 147–187 + 7 pl. 1954.

GENETICS AND CYTOLOGY

BACTERIAL GENETICS.

By Werner Braun. W. B. Saunders Company, Philadelphia and London. $6.50. xii + 238 pp.; ill. 1953.

This book can be divided into four major sections. In the first, genetic principles are reviewed. The second consists of 4 chapters summarizing knowledge of mutagenesis, mutagenic agents, and mutation, obtained from research with bacteria. The various types of bacterial mutants are extensively described. The third section considers population changes due to mutation and selection, and those due to enzymatic adaptation. In the fourth, bacterial recombination, transduction, and transformation are reviewed.

To whom is *Bacterial Genetics* directed? The author states, ". . . the text endeavors to furnish a general account of the present status of bacterial genetics which, it is hoped, is elementary enough for the beginning student and sufficiently comprehensive to be of value to the research worker" (presumably in bacteriology). These are rather broad objectives, and it is perhaps not surprising that the author falls short of either objective. Firstly, inasmuch as genetic principles pervade all of the biological sciences, including bacteriology, it is seriously to be doubted that there is any substitute for a course in the principles of classical genetics for the beginning bacteriology student today. The 15 per cent of the text devoted to a review of genetic principles is necessarily rather sketchy and inadequately illustrated. Further, the specialized field of bacterial genetics cannot reasonably be divorced from the general subject of microbial genetics, either for the beginning student or for the research worker. As a consequence of restricting examples to bacteria certain aspects are of necessity incompletely developed. Secondly, Braun pleads a need for the book on the grounds that the fundamental contributions are widely scattered in journals not read by bacteriologists. However, a compilation of the references shows that over one-half are in bacteriology journals and many of the significant papers have been compiled recently by Lederberg and reprinted by the University of Wisconsin Press, 1952. Thirdly, *Bacterial Genetics* is of questionable value for the research worker because much of the text is incompletely documented and uncritical. For example, in the conclusion of the section on population changes due to mutation and selection the value of the lyophil technique is questioned as follows, ". . . it has been observed with bacteria as well as with fungi, that after reconstitution of apparently homogeneous lyophilized cultures a small percentage of previously undetected variants may be present. . . . Experimental studies have indicated that the effect is not due to selective killing." The reference to fungi concerns inconclusive results obtained after lyophilizing mixtures of mutant yeast cells (not homogeneous cultures). The reference to bacteria concerns a report of Braun's own research on *Brucella* in which no data are presented and it is concluded that lyophilizing can produce changes due to selective killing. Other significant papers on the effect of lyophilization are not referred to.

The large section on population changes is both adequately developed and well pointed, and would appear to be the chief justification for publication of the book. *Bacterial Genetics* covers a new and rapidly developing field and serves to introduce the field to those who have been occupied with other areas of bacteriology.

R. W. BARRATT

NUCLEO-CYTOPLASMIC RELATIONS IN MICRO-ORGANISMS. *Their Bearing on Cell Heredity and Differentiation. Being The William Withering Memorial Lectures Delivered at The Birmingham Medical School, 1952.*

By Boris Ephrussi. Oxford University Press, New York. $3.75. viii + 127 pp. + 4 pl.; text ill. 1953.

This short book is a somewhat expanded version of three lectures delivered at the Birmingham Medical School by Boris Ephrussi, Professor of Genetics at the University of Paris, and in which he presents experimental evidence for the genetic continuity of the cytoplasm and discusses the possible role of the cytoplasm in cell differentiation.

The divergence of cell lines during the embryonic development of a metazoan is one of the most fascinating problems of biology. Although much progress has been made in describing the overall patterns of differentiation, metazoans have in general proved refractory to the analysis of the basic mechanisms involved. Recent genetic studies with microorganisms have turned up cases of cellular transformation or differentiation which might serve as models for such mechanisms.

One such case is that of Ephrussi's own studies on cytoplasmic heredity in yeasts. Through the action of euflavine or by some unknown, naturally occurring mechanism, normal yeast cells may be irreversibly

transformed to cells deficient in the respiratory enzymes cytochrome oxidase, cytochromes a and b, and succinic dehydrogenase. This transformation is due to the loss of some cytoplasmic factor, presumably a mitochondrium, and can occur without any genic change. Ephrussi and his coworkers have shown that the cytoplasmic factor appears to be dependent on a dominant gene for its function, but independent of it for its reproduction. These studies and a short discussion of visible cytoplasmic structures endowed with genetic continuity (kinetosomes, kinetoplasts, mitochondria, and chloroplasts) complete the first chapter.

The second chapter is devoted to the ciliated protozoan, *Paramecium aurelia*, the organism primarily responsible for our revived interest in the cytoplasm in respect to heredity. The first case discussed is that of the now classical studies of Sonneborn and his coworkers on the killer trait. Killer animals liberate a poison which is taken up by sensitive paramecia and causes their death. The capacity to produce this poison is controlled by the cooperative action of a nuclear gene and visible desoxyribose nucleoprotein cytoplasmic factors. A killer animal may be irreversibly transformed to a sensitive animal without altering the nucleus, by the elimination of the cytoplasmic particles. In the absence of the appropriate gene these particles do not reproduce and the animal also becomes sensitive. The nuclear gene is thus necessary for the reproduction of the cytoplasmic particle, in this case, but cannot initiate its production.

Perhaps the most important case of cytoplasmic heredity is that of the inheritance of antigenic types in *Paramecium*, studied by Sonneborn and Beale. The progeny of a homozygous paramecium may exhibit a whole spectrum of heritable antigenic types, only one of which will be expressed in a given individual at any one time. The capacity to produce the various antigens in a spectrum is under the control of the nucleus, a given locus controlling each antigen. However, directed transformation from one antigenic type to another can be readily induced through the agency of a number of environmental conditions. These transformations are both persistent and heritable and, most importantly, are readily reversible. Beale has demonstrated that the cytoplasm determines which of the many genes in control of the different antigens may come to expression.

The third chapter considers the work of Rizet on the barrage phenomenon in the mold *Podospora anserina*. This work is largely unpublished and is as yet incompletely analyzed, but it appears to involve cytoplasmic and nuclear factors and seems to be reversible.

Divergence of cell lines due to cytoplasmic changes occurs in microorganisms in the absence of genic changes. Since genic equality of the cells of a metazoan is generally accepted as a basic premise, irreversible segregation of cytoplasmic components or reversible transformations, as in the antigen story, could well result in somatic differentiation.

From the evidence presented in this book the cytoplasm most certainly has a measure of autonomy from, and an influence on, the functioning of the nucleus. Conversely, the best analyzed cases of cytoplasmic heredity show that the cytoplasm is not completely independent of the nucleus. Rather, the nucleus and cytoplasm are partners in control of heredity and development, as most biologists have at least intuitively known. It is from the study of the interrelations of these partners that an understanding of somatic differentiation will come.

Except for the work on *Podospora*, most of the information contained in this volume has had wide dissemination among microbial geneticists. Much of the speculation on the role of the cytoplasm in cellular differentiation has been discussed previously by others, especially Sonneborn. It may be hoped, however, that this concise and clearly written statement of the status and significance of cytoplasmic heredity will reach a larger audience of biologists for their consideration and assimilation.

MYRON LEVINE

BACK CROSSING. *The Theory and Practice of the Backcross method in the Breeding of Some Non-Cereal Crops. Tech. Commun. 16.*

By Mary Thomas. Commonwealth Bureau of Plant Breeding and Genetics, Cambridge (Commonwealth Agricultural Bureaux, Farnham Royal, England). 15s. 1d. vi + 136 pp. 1952.

This book describes applications of the "backcross technique" to cotton and three solanaceous crops: tobacco, tomatoes, and potatoes. The work of Briggs and others on backcrossing in cereals was assumed by the author to be fairly generally familiar and was therefore omitted. To some readers it will come as a distinct surprise to what extent interspecific hybridization, frequently involving species not closely related and with different numbers of chromosomes, has been used and successfully used in the improvement of crop plants. As a compilation of case histories of interspecific and intraspecific backcrossing, Mrs. Thomas' book may serve those who specialize in the breeding of the crops mentioned. But a painstaking and perhaps complete enumeration of pedigrees, variety designations, and station names in filing-case order provides no stimulus to the reader unless theory and evaluation play the tune. Here, I feel, this work is decidedly deficient. It is a book not to be read, although it may serve as a checklist of accomplished breeding experiments. Such a guide may be welcomed by breeders who are located at small stations with inadequate libraries, inasmuch as it brings together materials from the far-flung corners of the

earth and from very inaccessible station reports. Yet one may feel that this is a rather unnecessary book, since the job has already been done and is being continued by *Plant Breeding Abstracts*, from which all but a few of the included citations were taken.

I did not find many errors; the most serious was the inclusion of a case of breeding for resistance to certain ailments of tobacco under the heading of tomato breeding.

D. U. GERSTEL

MORBUS ALZHEIMER AND MORBUS PICK. *A Genetic, Clinical and Patho-Anatomical Study.*

By Torsten Sjögren, Hakon Sjögren, and Åke G. H. Lindgren. Ejnar Munksgaard, Copenhagen. D. kr. 35.00 (paper). 152 pp.; ill. 1952.

The Scandinavian contributions to human genetics are universally known. The monograph at hand is one of those initiated by Torsten Sjögren, the head of psychiatry at the Karolinska Institute Medical School in Stockholm. The diseases covered by the study are not so well known and are not common, about one person per thousand being victims of these senile psychoses.

The clinical and pathological studies of Morbus Alzheimer and Morbus Pick are of less significance for the biologist than the genetic considerations. The first difficulty is that the two diseases are similar enough to suggest a common genetic basis. The various lines of evidence presented indicate that the inheritance of the syndrome, if there is a common genetic basis, is that of a dominant gene with moderately good penetrance.

SHELDON C. REED

GENERAL AND SYSTEMATIC BOTANY

PLANT GENERA. *Their Nature and Definition. A Symposium. Chronica Botanica, Vol. 14, No. 3.*

By G. H. M. Lawrence, I. W. Bailey, Arthur J. Eames, Reed C. Rollins, Marion S. Cave, and Herbert L. Mason; with an introductory essay on Generic Synopses and Modern Taxonomy, by Theodor Just. Chronica Botanica Company, Waltham; Stechert-Hafner, New York. $2.00 (paper). Pp. 91–160; ill. 1953.

The six papers here included were first presented at the A. I. B. S. meetings at Ithaca in September, 1952. The editor of *Chronica Botanica* has done the botanical public a favor by publishing a highly significant symposium, the papers composing which gain by their contiguity. It is interesting that, in his Editor's Foreword, Frans Verdoorn comments on the "now almost unbridgeable gap between taxonomy, on the one side and general biology, on the other side." These remarks are in connection with a plea for the preparation of modern floras at the generic level. It is perhaps true that plant taxonomists have been remiss in their failure to produce such generic floras, but a fundamental problem lies in the very subject of this symposium—the nature and definition of plant genera.

The six papers are a very effective illustration that the gap between taxonomists and general biologists is in fact bridgeable; they abound with instances of fruitful collaboration between the practitioners of taxonomy and those of other disciplines. The anatomical approach to the study of genera (Bailey) demonstrates that anatomical characters, while inherently no more reliable than exomorphic ones, are susceptible to equivalent and equally valid uses. In reviewing the use of floral anatomy as an aid in generic limitation, Eames gives numerous examples of the assistance taxonomists may receive from the application of this discipline to their problems. Cytogenetical approaches (Rollins) may aid substantially in building up an evolutionarily sound generic classification. Cytology and embryology (Cave) are of great value in classification, particularly of the larger taxonomic entities such as genera and tribes. The role of plant geography in taxonomy (Mason) has been traditionally recognized, the facts of geographic distribution being best applied to problems of classification and phylogeny when they are considered in correlation with other facts used as evidence of relationship.

All of the speakers whose papers are here presented have emphasized the points of contact between their special disciplines and plant taxonomy; all seem to agree that the taxonomist, at least in principle, profits from these various approaches. One hopes that the current trend of mutual understanding and helpfulness will be accelerated. At any rate, one does not receive the impression from these papers that modern plant taxonomy is as isolated as its critics assume. It is quite possible that cooperative studies of this sort will be more useful in classification at the generic level than at the levels of species and family. If so, only the magnitude of the task and the inertia of short-handed taxonomic staffs need impede the preparation of a uniform series of generic floras, of the type vizualized by Theodor Just in his introductory essay on generic synopses and modern taxonomy.

A. C. SMITH

STANDARDIZED PLANT NAMES. *A Revised List of Standard Common Names for the More Important Australian Grasses, Other Pasture Plants, and Weeds. Bull. No. 272 (superseding Bull. No. 156).*

Commonwealth Scientific and Industrial Research

Organization, Melbourne. Free upon request (paper). 132 pp. 1953.

TAXONOMIC TERMINOLOGY OF THE HIGHER PLANTS. *By H. I. Featherly. The Iowa State College Press, Ames.* $3.75. x + 166 pp. 1954.

The first of these two volumes should prove very useful to those Australians who would know more of a flora with which they may be partially acquainted. Two indices are provided. The first—Botanical Names Index—lists in 3-column format Botanical Name (alphabetically), Approved Botanical Name, and Standard Common Name. The second—Common Names Index—lists similarly Common Name, Standard Common Name, and Scientific Name. Any plant, known by whatever name, can be conveniently cross-checked. No information other than names is included.

The second volume is essentially a dictionary of terms used in the taxonomy of the pteridophytes and spermatophytes. A glossary of terms covers some 70 pages, and is most inclusive. These terms are then repeated under a subject classification, beginning with Aestivation and ending with Venation. A third section deals with the meaning of words used in species designation; a fourth lists and explains some Greek and Latin components of scientific words; while a brief final appendix of 6 pages summarizes the pertinent facts of floral evolution, states the laws, theories, and hypotheses pertaining to taxonomy, and concludes with a discussion of phyllotaxy. Altogether, the volume should provide the taxonomist with a very workable pocket dictionary.

C. P. SWANSON

INTRODUCTORY MYCOLOGY. *By Constantine John Alexopoulos; art work by Mrs. Sun Huang Sung. John Wiley & Sons, New York.* $7.00. xiii + 482 pp.; ill. 1952.

This book meets a long-felt need in the field of mycology, for, as the name implies, it presents a general survey of the fungi, and presents this very well indeed. The book is clearly written, and beautifully and profusely illustrated. Whereas some figures are taken either from published papers or have been provided by collaborators representing specialists in particular fields, the great majority were prepared specifically for this text by Mrs. Sun Huang Sung. Many are redrawn from standard sources; others are original for this text; all are presented in a simple diagrammatic style which immediately conveys to the user the salient characteristics which distinguish the many fungus groups with their diverse methods of growth and of reproducton.

The book is divided into 17 chapters, beginning with a comprehensive introduction, entitled The Fungi, which serves to acquaint the student with basic concepts essential to an understanding of the chlorophyll-less plants which constitute the fungi. Then follow chapters on the Schizomycophyta, Myxomycophyta, the larger divisions of the Phycomycetes (4), Ascomycetes (4), and Basidiomycetes (3), together with a final and very brief chapter on the Lichens. The Deuteromycetes, commonly known as the Fungi Imperfecti, are considered separately but immediately following the Ascomycetes, since the vast majority of these fungi represent asexual forms of the latter class. The book closes with an excellent glossary, the customary acknowledgements, and an index.

The book does not presume a prior knowledge of mycology on the part of the reader, a condition which has been all too prevalent in the case of most so-called mycology texts previously available. At the same time it is not written in a manner to alienate the experienced worker, and the mycologists who cannot profit by reading this book are few indeed. The specialists will find deficiencies in the treatment of groups or phenomena with which they are particularly familiar. Yet we must realize that the author here covers the whole gamut of the fungi. To me, this seems to have been accomplished with exceptional balance.

The book has several interesting features. Not least among these is the manner in which Alexopoulos presents the etymology of all technical terms introduced. Consideration of the Deuteromycetes immediately following the Ascomycetes is a welcome innovation, and should go far toward dispelling the usual confusion which arises from the known dual nature of many of them. As might be expected, Alexopoulos accords the slime molds considerably greater attention than previous authors of mycology texts have done.

One possible criticism of the book lies in its failure to stress the importance of the fungi in human affairs. This, of course, is not totally ignored. Neither is it presented in a manner to convince the beginning student that being a mycologist is very important—that in choosing this profession one can make far-reaching contributions to human welfare, on the one hand by limiting the depredation of the fungi as pathogens, plant and animal, and on the other by harnessing them to useful ends.

KENNETH B. RAPER

LABORATORY MANUAL FOR INTRODUCTORY MYCOLOGY. *By Constantine J. Alexopoulos and E. S. Beneke. Burgess Publishing Company, Minneapolis.* $3.25. iv + 177 pp.; ill. 1952.

This laboratory guide is designed for use as a companion piece to the textbook, *Introductory Mycology*, by the senior author. It opens with an introductory section on methods for studying the fungi, methods including the preparation of suitable slide mounts for the observation of different types of material, culture techniques and media applicable for the cultivation of various

groups of fungi, methods of collecting and preserving specimens, and sources of supplies needed in the study of mycology. Then follows an abbreviated classification of the fungi and an extended series of exercises centered upon selected genera and species, arranged in the same general order that these fungi are considered in the textbook. It is difficult to see how all the material presented could be covered in the usual introductory course in mycology. Happily, however, each exercise is sufficiently complete in itself so that the instructor can make selections to fit the limitations imposed by time. Like the textbook, the *Laboratory Manual* is illustrated with drawings made by Mrs. Sung, and while these suffer by comparison because of the method of reproduction, they will, nevertheless, be very useful to the student.

KENNETH B. RAPER

PLANT MORPHOLOGY

MORPHOGENESIS IN PLANTS.

By C. W. Wardlaw. John Wiley & Sons, New York. $2.25. xi + 176 pp. + 4 pl.; text ill. 1952.

The morphogenesis of plants has become an increasingly important subject of research during the late two decades. As considered by the author, its scope includes all the activities involved in development of the distinctive form and structure characteristic of the adult state. Its interpretations involve the integration of data from all fields of study. Thus it is regarded as having a special importance as a focal point in botanical science.

Against a background of the working methods and problems of morphogenesis, the author illustrated with selected examples the results which have been achieved, and considers some of the general concepts which have emerged. Following an introductory chapter, problems relating to morphogenetic expression in plant embryos, the shoot apex, and leaf formation are treated in separate chapters. Other chapters emphasize the importance of mathematical analyses and studies of biochemical factors and genic control to an understanding of the development of plant form. The final chapter is devoted mainly to a brief analysis of the action of various factors in morphogenesis and to emphasis on the fact that an understanding of morphogenesis contributes to the comprehension of an even broader theme in biology, that of evolution.

This survey of morphogenesis integrates the more significant aspects of the subject with only a minimum of the details of problem and experiment. It reflects the breadth and insight which characterize the personal contributions of the author to this field of research. In addition to whatever value this monograph may have to the specialist, it deserves recognition for its meaningful presentation of the subject to the general botanist. It should contribute to a wider appreciation of the importance of this field of study.

CHARLES HEIMSCH

PLANT PHYSIOLOGY

GROWTH AND DIFFERENTIATION IN PLANTS. *A Monograph of the American Society of Plant Physiologists.*

Edited by Walter E. Loomis. The Iowa State College Press, Ames. $7.50. ix + 458 pp. + 10 pl.; text ill. 1953.

It is the practice of the American Society of Plant Physiologists to publish at intervals a monograph on some fundamental aspect of plant physiology. The present volume, the third in the monograph series, deals deals with the problems of growth and differentiation in plants. The 18 chapters, written by a number of workers in the field, cover such subjects as heterosis, dormancy, photoperiod, vernalization, physiology of hormone action, hormonal control of flower initiation, plant morphogenesis, and comparative physiology of heterotrophic growth in plants. Some of the papers are essentially research reports and present new material, whereas the others are review articles. The papers are well written, and the several authors have adequately covered their assigned topics. A question might be raised about the value of some of the reviews, which do not carry the literature past 1951. However, the field of growth and differentiation is complex, and the material presented in this volume does not greatly suffer from being a little out of date. The subjects covered are of fundamental importance, and all plant science workers will find much to interest them in the volume.

G. R. NOGGLE

ECONOMIC BOTANY

PRACTICAL FIELD CROP PRODUCTION FOR THE NORTHEAST. *An Elementary Introduction to Agronomy. Revised Edition.*

By Gilbert H. Ahlgren, Robert S. Snell, John C. Anderson, Milton A. Sprague, and Van Wie Ingham, Editor. Rutgers University Press, New Brunswick. $4.75. x + 432 pp.; ill. 1952.

This book appeared first in 1947, and has now been revised with the inclusion of some new material. As the title indicates, it centers its attention on the farm crop production in the states from Ohio and West Virginia to Maine. The level of treatment is uniform and is directed to the student in a vocational school or perhaps in a beginning course in a land-grant college. The interrelationships between livestock enterprises

and crop production are brought out more clearly than in most textbooks in this field. Pasture management and forage-crop handling are well treated, as is appropriate in view of their importance in the agricultural economy of the northeast. The book concludes with a chapter on efficient crop production which contains a lot of good sense.

The chief shortcoming of the book might be the absence of adequate attention to the soil, a not uncommon failing among farm crop production men. Even the best crop management recommendations may be ineffective if the soil fertility is low. The authors recognize that "the soils of the Northeast are generally acid and low in fertility and organic matter" and that "soil improvement practices must be used to produce crops economically," but they fail to give adequate emphasis to such questions as the importance of soil tests in developing the proper soil management regime that is basal to success in crop production.

The chapter on chemical weed control could easily have been more up to date with respect to practices now widely and intensively used in the northeast. This is, of course, a fast-moving field, and there may yet be changes in materials and methods. It is surprising to find no reference to pre-emergence and post-emergence herbicidal treatments, or to the control of invasion of pastures by brushy species.

In the revision certain figures might well have been brought closer up to date. Fig. 2 (livestock on farms) does not go beyond 1947, nor Fig. 3 (acreage of principal crops) beyond 1941. Fig. 8 (average number of men by months on certain dairy farms) is for 1939, and Table 5 (prices paid for field crops) for 1949. All in all, however, this is a competent book, clearly written, and well suited to the audience for which it is intended.

A. G. NORMAN

RICE.

By D. H. Grist. Longmans, Green & Company, London, New York, and Toronto. $6.75. xx + 331 pp. + 34 pl.; text ill. 1953.

Rice is an excellent treatise on the crop that nourishes the millions of inhabitants of southeast Asia. The author has a broad understanding of all phases of rice culture and of the part it plays in the health and well-being of the Oriental peoples from the standpoint of nutrition as well as economics. The author is well qualified to write on the subject because of his long service as an agricultural economist in the rice-growing area of the Orient. Moreover, the volume fills a real need, since there is no other recent book on this subject. It brings together for the first time in more than thirty years the latest information on all phases of rice production and its importance in the economy of southeastern Asia. The book is well documented, approximately 300 references being listed. Appropriately, the volume opens with a discussion of the origin and history of rice. The earliest historical references to this crop are found in Chinese writings of about 5000 years ago. It was introduced into Indonesia around 1500 B.C., but did not reach Africa and the Mediterranean Europe until about 375 B.C. It was introduced into the Western Hemisphere by the Portugese and Spaniards in the early fifteenth century.

The author discusses the characteristics of the rice plant, and goes into the gross morphology of the root, stem, leaves, inflorescence, and grain. Of the three factors—soil, climate and water supply—the last is by far the most important in producing a crop. Ideally, a gentle flow of water through the paddies is stated to be more desirable than stagnant water. The author discusses irrigation methods and equipment employed in the different rice-growing areas of the world and presents excellent photographs in illustration.

There are many varieties of rice, and the author indicates the preference of each part of the world for rices of different types. The Japanese prefer the short-grained semiglutinous while the Filipinos prefer the long-grained hard rice.

The chapter on pests of rice describes the most important insects attacking the crop. This chapter, too, is well illustrated with colored as well as black and white plates. The diseases of rice are treated separately and their causal agents and symptoms are described briefly. The "White Tip" disease is discussed under the heading of deficiency diseases and attributed to improper calcium and magnesium nutrition. Recent developments in this area have disclosed that "White Tip" is caused by the nematode *Aphelenchoides besseyi*.

Methods of planting, transplanting, cultivation, irrigation, and harvesting in the many different rice-growing areas of the world are presented in detail. Many photographs are used to show the types of equipment used in the production of the crop in the various areas. Included are illustrations of hand sowing and transplanting in India, Malaya, and other parts of the Orient as well as sowing from aircraft, as practiced in some areas of the United States. Fertilizer practices are discussed, but it is concluded that more research is required before definite fertilizer recommendations can be made for certain parts of the Orient.

Losses of stored grain resulting from a number of causes are discussed. The milling process, including cleaning, hulling, pearling, polishing, and grading, is described; and the equipment employed in each of these processes is pictured. The author describes some of the industrial uses of rice, such as its uses a source of starch and flour, in beverages, and in cosmetics.

The nutritional value of rice receives detailed attention in a separate chapter. Production yields, consumption, and economic conditions in the rice-growing areas complete the volume.

This book should be very valuable to persons conducting research or teaching in the fields of agronomy

or plant pathology, as well as to others who are interested in the broad aspects of world agriculture. The story of rice, as presented in this volume, is told in an interesting manner and is a sound technical presentation.

C. E. MINARIK

GENERAL AND SYSTEMATIC ZOOLOGY

LEITFADEN FÜR DAS ZOOLOGISCHE PRAKTIKUM. *13th Edition.*

Founded by Willy Kükenthal; continued by Ernst Matthes. Gustav Fischer Verlag, Stuttgart. DM. 24.00. viii + 412 pp.; ill. 1953.

Fashions change in zoological teaching, but there is still much to be said for the old-style zoological course that began with the amoeba and ended with the cat or rabbit. This time-tested German manual operates on that scheme. It ascends through the animal kingdom and presents one or more types for each of the principal groups. For each group there is a short discussion of its general characteristics—"allgemeine Übersicht"—and this is followed by a description of the selected type. These descriptions are written up rather in an expository way than as concrete laboratory directions. There are many figures, many of them more or less original, the type is clear, and the book lies open at any desired page. Vertebrate types include an elasmobranch and bony fish, frog, lizard, pigeon, and rabbit. While offering nothing new or original, this book would give anyone who followed it through a thorough grounding in zoological morphology.

L. H. HYMAN

PRAKTIKUM DER WEICHTIERKUNDE.

By S. H. Jaeckel. Gustav Fischer Verlag, Jena. DM 5.20 (paper). iv + 87 pp.; ill. 1953.

A manual for the collection, preservation, rearing, and dissection (both gross and histological) of mollusks, with information on classification and a section on mollusks of economic importance in Germany (including *Teredo*). There is a useful bibliography and a 7-page glossary of terms.

INTERTIDAL INVERTEBRATES OF THE CENTRAL CALIFORNIA COAST.

S. F. Light's "Laboratory and Field Text in Invertebrate Zoology," revised by Ralph I. Smith, Frank A. Pitelka, Donald P. Abbott, and Frances M. Weesner, with the assistance of many other contributors. University of California Press, Berkeley and Los Angeles. $5.00. xiv + 446 pp.; ill. 1954.

This is a revision of S. F. Light's *Laboratory and Field Text in Invertebrate Zoology*, which represented "accumulations from fifteen years of teaching the natural history of the invertebrates of the central California coast." That first edition, like the present revision, was concerned primarily with teaching students to recognize animal groups and to identify the more common and characteristic invertebrates of the area in question. Attempts of this kind in North America are always handicapped by the deplorable lack of exact knowledge of the invertebrate fauna of our coasts, as regards many groups. The various collaborators have struggled manfully with this difficulty and have produced an attractive volume that should be of service in the area indicated, but that will not be of great value elsewhere. Further, the identification of invertebrates to species is so difficult, except in a few forms with distinctive colors, that students can scarcely be expected to cope with it even with the assistance given in such manuals and keys as the present. The volume proceeds by phyla. Each phylum is introduced with a general account of its morphology and usually a glossary of taxonomic terms, and this is followed by a key to the species to be expected in the region in question. A considerable number of illustrations of anatomy and of typical species is provided. Fish and marine algae are included, and the volume concludes with field directions and instructions for laboratory studies of animals brought in from the field. This volume will undoubtedly meet with great local enthusiasm from those interested in seashore life and should set an example for similar volumes covering other areas. In its striving for exactness in identification and nomenclature it is far superior to the usual seashore guide, which generally is constructed from the literature rather than from actual field studies and often presents long outmoded scientific names.

L. H. HYMAN

THE MEDUSAE OF THE BRITISH ISLES. *Anthomedusae, Leptomedusae, Limnomedusae, Trachymedusae and Narcomedusae.*

By Frederick Stratten Russell. Cambridge University Press, New York. $22.50. xiv + 530 pp. + 35 pl.; text ill. 1954.

Medusae are among the most beautiful of animals and this volume does full justice to them, being illustrated with 31 delicately tinted plates as well as photographs and numerous line drawings in the text. As indicated by the subtitle, the volume is limited to hydrozoan medusae, which are classified into 5 orders; Kramp's order Limnomedusae for *Gonionemus* and its allies is recognized in addition to the usual 4 orders. The volume opens with an account of the structural characters and life histories of hydromedusae. A pictorial key consisting of small outline sketches of the species should simplify identification. There are de-

scribed about 90 species, in contrast with the 24 species in Forbes' well-known work of 1848. The text proceeds by families, under which the genera and species are keyed out. For each species all of the available information is given, including the hydroid stage, habits, occurrence, and so on. The author is a well-known student of plankton and states that he first became interested in medusae as indicators of movements of water masses in the sea. An intention to bring the hydroid and medusoid stages under one system of nomenclature was abandoned as impractical because of imperfect knowledge of the hydroid stages; therefore the old system of separate names for the two stages in many cases is retained. This handsome volume is a monument to painstaking scholarship and will be appreciated by lovers of invertebrates throughout the world.

L. H. HYMAN

TAXONOMY, DISTRIBUTION AND DEVELOPMENT OF THE EUPHRAUSIACEA (CRUSTACEA). *Rep. B.A.N.Z. Antarct. Exped., Ser. B (Zool., Bot.), Vol. VIII, Part I. By Keith Sheard. B.A.N.Z.A.R. Expedition Committee, Adelaide; issued through the Barr Smith Library, University of Adelaide.* 32s. (paper). 72 pp.; ill. 1953.

Continuing these valuable reports, the present section deals with an imperfectly known group of small crustaceans, of importance in the marine economy. They are less often collected than copepods because of their habit of dwelling in the bottom layers to feed on detritus. The present study gives a complete systematic survey of the group, which contains 65 species, and discusses at some length the geographical distribution of the euphausiaceans. The latter half of the article is devoted to growth and development, with special reference to *Nyctiphanes australis*, of which abundant material was secured.

L. H. HYMAN

THE SPIDER GENERA XYSTICUS, CORIARACHNE, AND OXYPTILA (THOMISIDAE, MISUMENINAE) IN NORTH AMERICA. *Bull. Amer. Mus. nat. Hist., Vol. 102, Art. 4. Willis J. Gertsch. American Museum of Natural History, New York.* $1.00 (paper) Pp. 413–482; ill. 1953.

This work is purely taxonomic and represents a supplement to Gertsch's larger work on the subfamily of typical crab-spiders, published in 1939. A total of 95 species is included here, and of these 24 are indicated as new to science. The descriptions of the latter are quite detailed for the most part, and are accompanied by drawings illustrating important diagnostic characters. For the 71 other species notes and briefer descriptions are supplied, and any new distribution records made known since 1939 are included. Araneologists will find this paper a valuable addition to their working taxonomic literature.

B. J. KASTON

AUDUBON'S BUTTERFLIES, MOTHS, AND OTHER STUDIES. *Compiled and edited by Alice Ford. The Studio Publications in association with Thomas Y. Crowell Company, New York and London.* $5.75. 120 pp.; ill. 1952.

The recent discovery of a sketchbook of 15 pages of water-color paintings of insects and reptiles done by John James Audubon in 1821 and 1822 in Louisiana has furnished the substance of this book. In addition to reduced photographs of the pages, most of the paintings are also reproduced in facsimile both as to size and color. Of the 40 plates, no less than 17 are in color. The text, broken into rather disjointed sections, treats of Audubon's Birth, of The Sketchbook, Of Insects, and Of Reptiles.

Audubon's insects are depicted with his usual flair, but a study of them is nevertheless rather disappointing. Although some insects, like his dragonfly, are beautiful indeed, most of the paintings are clearly drawn from dead European or Caribbean specimens, stiffly and unnaturally posed. On the other hand they lack the verisimilitude of those insects, mainly painted by Maria Martin, which figure so beautifully in Audubon's *Birds*; and on the other hand they lack the strict accuracy of pattern and coloration seen in the work of later painters. Thus, a beautifully colored sphinx moth larva is of known N. American species and appears to be a blown and inflated, grossly distorted balloon of a caterpillar; and a beautifully painted beetle, probably *Popilius disjunctus*, the Bessybug, has clearly lost both its front tarsi. What is clear from the sketchbook may also be seen to apply to the insects definitely attributable to Audubon in the bird plates. Thus his Luna moth, in the Green Heron plate, conveys to a lepidopterist only a general resemblance to a real Luna; and the Io and Cecropia moths, in the Whip-poor-will plate, are harsh and ungrateful in color. These comparisons lead one to agree fully with the author of this text in her praise of Maria Martin, who did such an inestimable service to Audubon in supplying the backgrounds for many of his best plates, and whose merit has been clearly neglected.

On the other hand, Audubon's reptiles are beautifully and carefully done, and the greatest interest in this volume will surely be aroused by Audubon's jewel-like teeid lizard and annulated snake, beautifully reproduced in color. It is unfortunate that more of the reptiles and the single toad were not so reproduced, in place of some of the rather inferior insects.

The text, although over-rapturous like so many writings by Audubon's admirers, gives many interesting

sidelights into his difficulties and triumphs. The sketchbook itself was given by Audubon to a lady of Pittsburgh, Mrs. Charles Basham, and her daughter Harriet, as the sole token of his gratitude for their help the indigent Audubon could make in 1824. Through a Mrs. Kirby Chambers of Kentucky, who acquired the sketchbook from a descendant of the Basham family, it has now been made public.

BENTLEY GLASS

GUIDE TO THE INSECTS OF CONNECTICUT. *Part VI: The Diptera or True Flies of Connecticut. Fifth Fascicle: Midges and Gnats. Conn. geol. nat. Hist. Surv., Bull. No. 80.*

By O. A. Johannsen and Henry K. Townes, authors of Tendipedidae (Chironomidae); O. A. Johannsen, author of Heleidae (Ceratopogonidae); and Frank R. Shaw and Elizabeth G. Fisher, authors of Fungivoridae (Mycetophilidae). Printed for the Geological and Natural History Survey, Hartford. $1.00. viii + 255 pp.; ill. 1952.

This bulletin continues a series of papers on the Diptera of Connecticut, begun so auspiciously with Bull. No. 64. It is somewhat disappointing that this section does not meet the high standards set in the previous one. The present paper will probably be a help to those who desire merely to place a name on specimens of the groups which appear in the northeastern United States, and who may not be too concerned with exact specific identifications. Many non-specialists without access to, or familiarity with, the considerable literature on the families treated will use these papers, and since authors of all sections of the present bulletin, except that of the Tendipedini, merely list or include the species in keys without synonymy or descriptive notes, many unintentional but incorrect identifications will probably result. Townes's section on the Tendipedini is a notable exception, and might well serve as a model for future fascicles, if the *Guide* is to serve any serious purpose.

I was especially intrigued to compare the family Heleidae, as treated in this bulletin, with that of the California publication reviewed in the previous issue (*Q.R.B.*, 29: 170. 1954), and to find how many more species are known in both sexes in California than in the presumably more extensively collected northeastern region of the United States.

FRED M. SNYDER

SIMULIIDAE OF THE ETHIOPIAN REGION.

By Paul Freeman and Botha de Meillon. British Museum (Natural History), London. £2.10s. viii + 244 pp. + 1 pl.; text ill. 1953.

This is the first revision of the African species of this important family of bloodsucking flies to appear since 1930, at which time the junior author published on the 23 species then known. The present work contains 69 species, a reduction from the more than 100 that have been described. The introductory portion of the work contains well-prepared discussions of the life history adult habits, zoogeography, relation to disease, anatomy of adult, pupa, and larva, and techniques of collection, preservation, and examination of material. The medical importance of black-flies lies in the toxaemia produced by mass attacks, and to the transmission of human onchocerciasis, a disease of great importance in Africa and Central America, often leading to blindness. This work also includes a discussion of the species problem, a particularly difficult one in this family. In the Simuliidae, not only in Africa, but in many other regions, there are taxa that appear to differ only in the structure of the pupa, and the authors have here chosen to treat these as forms only. This may be their correct status, although there seems much evidence to consider them as reproductively isolated, sibling species. The family offers many interesting problems in speciation, and it is unfortunate that they are not better suited for laboratory rearing and experimentation.

The species included in this work are placed in two genera, *Cnephia* and *Simulium*. The latter genus is subdivided into two unnamed divisions, and these divisions into 7 species groups. Keys are given to the females, males and pupae, and most of the species are well illustrated. This is a very useful work that will be of great assistance in determining the species of tropical Africa.

ALAN STONE

A CATALOGUE OF THE AMERICAN HESPERIIDAE, *indicating the Classification and Nomenclature Adopted in the British Museum (Natural History). Part III (Groups E, F, G) Pyrginae. Section 2.*

By W. H. Evans. British Museum (Natural History), London. £2. 0s. 0d. vi + 246 pp. + 28 pl. 1953.

This is the third in the monumental series of revisional works on the Hesperiidae of the New World being prepared by Brigadier Evans at the British Museum. Part I covered the Pyrrhopyginae and Part II the first part of the Pyrginae, which this part concludes. In the preparation of this part some 25,000 specimens were studied; these are arranged in 79 genera (of which 12 are described as new), 351 species (58 new), and 258 additional subspecies (106 new). In addition, 38 genus names and 430 species and subspecies names are placed in synonomy. Of these, the British Museum has the types of 347 species and subspecies names recognized as valid and of 82 placed in synonomy. The entire text is arranged in the form of a key for identification, and the outlines of the essential parts of the male genitalia are given. No full bibliographic references are

listed, but since the author and year date are given for all names the interested student should have little trouble in finding any reference. Addenda and Corrigenda to Parts I and II are given.

There is no doubt that this is the most important single work ever published on this group of the butterflies, and that its influence will be both enormous and permanent. It is therefore extremely unfortunate the circumstances have forced the author to base his study entirely on the specimens in the British Museum for, peerless though that collection is, it is not adequate for the purposes of an all-inclusive revision. As a result, the distribution records of many of the species and subspecies are incomplete and, what is more important, a great deal of the synonomy will have to be redone due to the author's inability to study types, or even specimens, of many of the names which he synonomizes. In a group as notoriously difficult as the Hesperiidae there is absolutely no substitute for personal examination and comparison of the genitalia and other structures of types. However, the author has done a magnificent job with the facilities at his command, and both he and his institution are to be congratulated upon it.

ALEXANDER B. KLOTS

A MONOGRAPH OF THE IMMATURE STAGES OF BRITISH AND IMPORTED TIMBER BEETLES (CERAMBYCIDAE).

By E. A. J. Duffy. Printed by Order of The Trustees of the British Museum (Natural History), London. £4.4s. viii + 350 pp. + 8 pl.; text ill. 1953.

Having been told early in the introduction that the family Cerambycidae comprises more than 20,000 described species, it will no doubt come as a shock to the reader to learn that, with the avowed purpose of making possible the identification of the indigenous and imported cerambycid larvae of Great Britain, and of providing a world key, the author had perforce to restrict consideration to the mere 110 species that occur there. Craighead made use of some 280 species in drawing up his key of the larval Cerambycidae of North America alone. Yet he was content with the more modest objective of attaining an "artificial arrangement based on the more evident characters, so as to allow the determination of the genera and species by the most expedient means."

In assessing the value of the present key, recognition must be taken of the importance of a reliable means of identification, for, since these beetles have a protracted larval life, it is the larval stage that is most frequently encountered. Moreover, it is as larvae that the great majority of species do their damage, and, control being so often the first consideration, their early diagnosis becomes imperative. It is therefore gratifying that Duffy considers that his key renders possible the identification of larvae "of any instar except the first or, in some cases, the second."

The monograph includes 292 line drawings, most of them original and of extreme clarity; and ends with 40 photographs, taken by, but doing little credit to, the author. Five chapters follow a short introduction outlining objectives and dealing with the economic importance of the Cerambycidae. A general account of the biology of the cerambycids suffers through condensation into 40-odd pages; descriptions of larval and pupal morphology are adequately presented in 16 and 13 pages, respectively, to each of which are appended keys to subfamilies, genera, and species. The main section, over 200 pages in length and arranged under the 6 recognized subfamilies, provides descriptions of the immature stages, and bionomic data on them. There follows a mercifully short chapter on collection and preservation that climaxes a book replete with punctuative and other grammatical errors. The concluding pages contain between 800 and 900 references and an index that loses much in value by omitting the names of the authors so liberally cited in the text.

There are a number of surprising pieces of information: we are told that these beetles promote the dissemination of the prickly pear by gnawing off branches; that little need be said about fertility because "the majority of estimates given in the literature must be misleading"; that deciduous trees are gymnosperms and conifers are angiosperms; that cacti are herbaceous plants; and so on. Two related pearls of wisdom catch the eye: "elaborate precautions are taken for the concealment of eggs in most Lamiid species, and this may account for the fact that the average number of eggs in this subfamily is generally far smaller than that of other subfamilies"; and "in general, eggs of the *lamiinae* are larger than those of other subfamilies. This is probably due to the fact that species of this subfamily lay fewer eggs."

It is difficult to escape the conviction that publication of this monograph would better have been deferred for some ten or even twenty years.

STANLEY G. SMITH

LES CHAUVES-SOURIS DE MAROC. *Trav. Inst. sci. Chérifien, publiés par la Société des Sciences Naturelles du Maroc. Direction de l'Instruction Publique au Maroc. No. 1.*

By Jean B. Panouse. Editions Internationales. Tanger. 400 fr. (Paper). 120 pp. + 2 pl.; text ill. 1951.

This monograph opens with a short section (18 pp.) devoted to general information about bats. The systematic part (96 pp.) gives 2 keys, one to external features, a second to characteristics of skeleton and dentition; and describes the 21 species belonging to the families Rhinopomidae (2 spp.), Emballonuridae (1 sp.), Rhinolophidae (5 spp.), Hipposideridae (2 spp.) Vespertilionidae (10 spp.), and Molossidae (1

sp.). Of these species, the occurrence in Marocco of 5 is given as probable or possible. This part ends with a systematic catalog. The monograph is completed by a bibliography, a systematic index, and 2 plates illustrating silhouettes of bats in flight.

AN ANALYSIS OF THE DISTRIBUTION OF THE BIRDS OF CALIFORNIA. *Univ. Calif. Pub. Zool., 50, No. 6.*

By Alden H. Miller. University of California Press, Berkeley and Los Angeles. $1.50 (paper). Pp. 531–634; ill. 1951.

This important paper should be read by all students of animal distribution and by ecologists interested in animal communities. What Miller has done with the distribution of California birds is to compare three current systems: life-zones, formations (essentially plant communities and edaphic physical areas), and faunal areas. It is concluded that although each has certain merits, none is completely adequate. In California about one-fifth of the species are restricted to one life-zone, the majority are spread over two or three and a few occur in four or more. Lower Sonoran, Upper Sonoran, Transition, and Boreal are recognized, the latter being a fusion of Canadian, Hudsonian, and Alpine-Arctic, since no important differences could be discerned among the three. Twenty-one ecological situations are defined, of which 12 are terrestrial plant communities. The greatest number of birds occurs in riparian woodland, montane forest, and oak woodland. Again, most species were found to range through two or three formations; about 25 per cent were limited to one. Off-hand, it might appear that agreement here was no better than with with life-zones; but a closer look at some of the "formations" reveals that several, although composed of different kinds of plants, are quite similar in "anatomy," and hence probably belong to similar animal communities or to the same one. Nor are the biomes, as considered here, synonymous with the concept used by other ecologists. A reevaluation of the communities might therefore seem advantageous.

Four faunal areas are recognized: Boreal, Great Basin, Sonoran, and Californian endemic. The first three are intrusive faunas, ranging into the state from extensive developments in large areas to the north, east, and southwest, respectively. Within each, several provinces, districts, and smaller areas can be recognized. The most striking faunal contrasts occur along east-west hygrogradients which appear to have been responsible for the evolution of new forms.

The basic defect in any problem analysis such as this is the proper evaluation of the information available. If a bird does occupy two or more distributional areas, how is the observer to be sure that each has equal preference? How are we to be sure that what we think are different ecological situations are not so considered by the birds themselves and, vice versa, that what looks the same to us may be entirely dissimilar from the bird's point of view? A good, critical paper such as this provides much needed information and a stimulating impetus for further work in this direction.

HENRI C. SEIBERT

THE BIRDS OF JAPAN, THEIR STATUS AND DISTRIBUTION. *Bull. Mus. comp. Zool. Harv., Vol. 109, No. 4.*

By Oliver L. Austin, Jr., and Nagahisa Kuroda. The Museum of Comparative Zoölogy at Harvard College, Cambridge. $4.00 (paper). Pp. 277–637. 1953.

Since the publication of Seebohm's *Birds of the Japanese Empire* (1890), there has been for more than 50 years no publication in a Western language to summarize what has become known regarding the distribution, ecology, life-history, and systematics of the birds of Japan. In 1942 H. Jahn published in Germany his basic treatise *Zur Oekologie und Biologie der Vögel Japans*, which is based principally upon his own observations. Still there was lacking a single work wherein all the more significant results of the researches of the Japanese ornithologists—researches published almost entirely in the Japanese language—were brought to general knowledge. This gap is now filled by the present comprehensive publication, which is the fruit of an American-Japanese collaboration. Nagahisa Kuroda, the son of the well-known ornithologist Nagamichi Kuroda, had virtually completed in Japanese a manuscript on the subject, when he was won over to the plan of a joint work by Oliver Austin, who since 1946 had been stationed in Japan as head of the Wildlife Branch, Natural Resources Section, General Headquarters, Supreme Commander of the Allied Powers. In this volume all the data on the occurrence of 415 bird species are painstakingly brought together and documented. Over and above this, the authors have communicated many details about the ecology, reproduction, and migrations of the Japanese birds, and give morphological suggestions that will be welcome to the sytematist.

E. STRESEMANN

THE BIRDS OF THE BELGIAN CONGO, *Part 3. Bull. Amer. Mus. nat. Hist., Vol. 75A.*

By James P. Chapin. American Museum of Natural History, New York. $10.00 (paper). 821 pp. + 14 pl.; text ill. 1953.

Since 1914 Chapin has specialized on the birdworld of the Belgian Congo and has taken several extended journeys thither, the results of which have become of great importance not only to morphologists and systematists, but further to biologists in general. The incomparable knowledge of the author stands out in

this work, the first two volumes of which were published in 1932 and 1939, respectively. To the third volume, now appearing, a fourth will soon follow to complete the series. In comparison to other standard works on the birds of African lands, this one has the advantage that its author could base a great number of his facts upon his own experience. More exactly than anyone before him, he has dealt with the ecological factors, upon which the distribution of the bird species found in the Congo Region depends. In order to use the work to advantage, one must of course have become acquainted with African ornithology. Chapin makes no concessions to the novice. He addresses himself to the experienced systematist, zoogeographer, and student of behavior.

E. STRESEMANN

ZOOLOGICAL RESULTS OF A FIFTH EXPEDITION TO EAST AFRICA. *1. Mammals from Nyasaland and Tete, with Notes on the Genus Otomys. Bull. Mus. comp. Zool. Harv., Vol. 110, No. 1.*

By Barbara Lawrence and Arthur Loveridge. Museum of Comparative Zoölogy at Harvard College, Cambridge. $1.00 (paper). 80 pp. + 3 pl. 1953.

ZOOLOGICAL RESULTS OF A FIFTH EXPEDITION TO EAST AFRICA. *VII. Bull. Mus. comp. Zool. Harv., Vol. 110, No. 7.*

By A. Loveridge; with an appendix on The Avifauna by C. W. Benson. The Museum of Comparative Zoölogy, Harvard College, Cambridge. 85 cents (paper). Pp. 447–487 + 6 pl. 1953.

This report describes the itinerary of a trip undertaken in 1948–49. One purpose of the expedition was to ascertain how much of Nyasaland's primary forest fauna has survived. It is disheartening to report that most of the original forest is gone, and that naturally this has had adverse effects on its fauna. However, enough specimens were secured to help emphasize that (1) the fauna of the lowland swamps and savanna of Nyasaland is homogeneous with that of contiguous areas; (2) the few endemic forms are chiefly races of species occurring beyond its borders; (3) the higher mountain forms are related to those occurring at high altitudes both to the north and south. More intensive collecting is necessary to fill in the many gaps in this zoogeographical problem. C. W. Benson has added as an appendix a list of birds associated with the montane forests of Nyasaland and nearby areas.

HENRI C. SEIBERT

NEW AND LITTLE-KNOWN FALSE SCORPIONS (ARACHNIDA, CHELONETHIDA) FROM MONTEREY COUNTY, CALIFORNIA. *Bull. Amer. Mus. nat. Hist., Vol. 99, Art. 4.*

By Joseph C. Chamberlin, American Museum of Natural History, New York. 75 cents (paper). Pp. 263–312 + 2 pls.; text ill. 1952.

A REVIEW OF THE MEXICAN TIGER BEETLES OF THE GENUS CICINDELA (COLEOPTERA, CICINDELIDAE). *Bull. Amer. Mus. nat. Hist., Vol. 103, Art. 3.*

By Mont A. Cazier. American Museum of Natural History, New York. $1.50 (paper). Pp. 227–310 + 3 pl.; text ill. 1954.

THE BURROWING BEETLES OF THE GENUS MYCOTRUPES (*Coleoptera: Scarabaeidae: Geotrupinae*). *Misc. Publ. Mus. Zool. Univ. Mich., No. 84, Parts I, II, and III.*

By Ada L. Olson, T. H. Hubbell, and H. F. Howden. University of Michigan Press, Ann Arbor. 75 cents (paper). 59 pp. + 8 pl.; text ill. 1954.

A REVISIONAL STUDY OF NEOTROPICAL PSELAPHID BEETLES. *Part I: Tribes Faronini, Pyxidicerini and Jubinini. Spec. Publ. Chicago Acad. Sci., No. 9, Pt. 1.*

The Chicago Academy of Sciences, Chicago. $1.25 (paper). 49 pp. 1952.

REVISIONARY STUDIES OF SOME SOUTH AMERICAN TEIIDAE. *Bull. Mus. comp. Zool. Harv., Vol. 106, No. 11.*

By Rodolfo Ruibal. Museum of Comparative Zoology at Harvard College, Cambridge. 75 cents (paper). Pp. 477–529; ill. 1952.

A SYSTEMATIC STUDY OF THE AVIAN FAMILY FRINGILLIDAE BASED ON THE STRUCTURE OF THE SKULL. *Misc. Publ. Mus. Zool. Univ. Mich., No. 81.*

By Harrison B. Tordoff. University of Michigan Press, Ann Arbor. 75 cents (paper). 41 pp. + 11 pl. 1954.

BIRDS OF CENTRAL NEW GUINEA. *Results of the American Museum of Natural History Expeditions to New Guinea in 1950 and 1952. Bull. Amer. Mus. nat. Hist., Vol. 103, Art. 4.*

By Ernst Mayr and E. Thomas Gilliard. American Museum of Natural History, New York. $2.00 (paper). Pp. 315–374 + 22 pl. 1954.

MAMMALS COLLECTED BY MR. SHAW MAYER IN NEW GUINEA, 1932–1949. *Bull. Brit. Mus. (nat. Hist.) Zool., Vol. 1, No. 10.*

By Eleanor M. O. Laurie. British Museum (Natural History), London. 15s. (paper). Pp. 269–318; ill. 1952.

PHILIPPINE ZOOLOGICAL EXPEDITION, 1946–1947. MAMMALS. *Fieldiana; Zool., Vol. 33, No. 2.*

By Colin Campbell Sanborn. Chicago Natural History Museum, Chicago. $1.50 (paper). Pp. 89–158; ill. 1952.

GUIDE TO THE MAMMALS OF COLORADO.

By Hugo G. Rodeck. University of Colorado Museum, Boulder. 75 cents (paper). 72 pp.; ill. 1952.

RESULTS OF THE ARCHBOLD EXPEDITIONS, NO. 68. *Summary of the 1948 Cape York (Australia) Expedition. Bull. Amer. Mus. nat. Hist., Vol. 102, Art. 2.*

By L. J. Brass; with notes on the mammals of Cape York Peninsula by G. H. H. Tate. American Museum

of Natural History, New York. $1.00 (paper). Pp. 135–206 + 7 pl. 1953.

ECONOMIC ZOOLOGY

CARE AND BREEDING OF BUDGIES (SHELL PARAKEETS). *By Cyril H. Rogers. Dover Publications, New York.* $1.75 (cloth); 65 cents (paper). 93 pp. + 25 pl. 1953.

This little book is meant to provide sufficient information to enable any interested person to successfully keep, raise, and breed budgerigars, otherwise known as shell parakeets. Stock cages, nest boxes, breeding cages, feeding pans, and other requisite appurtenances are explained and illustrated. Hints on handling and taking care of the ill are included. Almost half of the book, however, is devoted to a description of color varieties, how to breed various combinations, the results to be expected therefrom, how to keep pedigree records, and how to properly exhibit the final efforts. Were I a parakeet owner I would prefer the emphasis to be on the care of one or two pets rather than on such an aviary scale—but for those who wish to expand, this book ought to help solve some of the problems involved.

HENRI C. SEIBERT

A RACIAL STUDY OF THE PACIFIC MACKEREL, *Pneumatophorus diego. Fish Bull., Sacramento, No. 84.* *By Phil M. Roedel. State of California Bureau of Marine Fisheries.* Free upon request (paper). 57 pp.; ill. 1952.

THE COMMERCIAL FISH CATCH OF CALIFORNIA FOR THE YEAR 1951, *with an Evaluation of the Existing Anchovy Case Pack Requirements. Fish Bull., Sacramento, No. 89.* *By the Staff of the Bureau of Marine Fisheries, State of California, Department of Fish and Game, San Pedro.* Free upon request (paper). iv + 68 pp.; ill. 1953.

STUDIES ON FISH PRESERVATION AT THE CONTRA COSTA STEAM PLANT OF THE PACIFIC GAS AND ELECTRIC COMPANY. *Fish Bull., Sacramento, No. 92.* *By James E. Kerr. State of California, Department of Fish and Game, San Pedro.* Free upon request (paper). 70 pp. + 1 chart; ill. 1953.

THE LIFE HISTORY OF THE CABEZON, *Scorpaenichthys marmoratus (Ayres). Fish Bull., Sacramento, No. 93.* *By Charles P. O'Connell. State of California, Department of Fish and Game, Marine Fisheries Branch, San Pedro.* Free upon request (paper). iv + 76 pp.; ill. 1953.

THE BEHAVIOR AND REPRODUCTION OF SALMONID FISHES IN A SMALL COASTAL STREAM. *Fish Bull., Sacramento, No. 94.* *By John C. Briggs. State of California, Department of Fish and Game, Marine Fisheries Branch, San Pedro.* Free upon request (paper). iv + 62 pp.; ill. 1953.

COMMON TUNA-BAIT FISHES OF THE CENTRAL PACIFIC. *Res. Rept. U. S. Fish. Serv., No. 34.* *By Fred C. June and John W. Reintjes. U. S. Department of the Interior, Fish and Wildlife Service, Washington.* 20 cents (paper). 54 pp.; ill. 1953.

THE STATUS OF THE HARBOUR SEAL IN BRITISH COLUMBIA, WITH PARTICULAR REFERENCE TO THE SKEENA RIVER. *Bull. Fish. Res. Bd Can., No. 93.* *By H. D. Fisher. The Fisheries Research Board of Canada, Ottawa.* 50 cents (paper). ii + 58 pp.; ill. 1952.

ANIMAL GROWTH AND DEVELOPMENT

JOURNAL OF EMBRYOLOGY AND EXPERIMENTAL MORPHOLOGY. *Vol. 1, No. 1. March, 1953.* *Editor, M. Abercrombie. Published for the Company of Biologists, Ltd., at the Clarendon Press, Oxford.* Issued quarterly. Annual subscription, £4. 4s. 0d.; single copies, 25s.

"The main object of the Journal is to bring together work concerned with all kinds of developmental process to be found in animals at any stage of their life-history. It will include work on embryology (descriptive, experimental, chemical, physiological), on regeneration and healing, on the developmental changes involved in functional adaptation, on growth, ageing, and other aspects of late morphogenesis. It will publish studies of gametes and gametogenesis where the work is not primarily of cytological interest; and studies of developmental genetics and of the physiology of reproduction where these fall more within its scope than within the usual scope of existing specialized journals. Papers on those aspects of protozoology which have a bearing on morphogenesis will be acceptable. Papers concerned with developmental processes in plants may be included if they connect with zoological aspects of morphogenesis."

Following a Foreword by A. M. Dalcq, the first issue contains the following 6 papers: Les effets de la centrifugation sur la blastula et la jeune gastrula des Amphibiens. I. Mécanisme de la formation des organes secondaires aux dépens de l'ectoblaste (J. Pasteels); Distribution of Antigens in the Developing Newt Embryo (R. M. Clayton); Rate of Regeneration in Planarians after Starvation (H. V. Brøndsted); The Acceleration of Regeneration in Starved Planarians by Ribonucleic Acid (A. & H. V. Brøndsted); Essais de cultures *in vitro* d'organes embryonnaires en milieux synthétiques (Et. Wolff, K. Haffen, M. Kieny, & Em. Wollf); Development and Structure of the Saccus Vasculosus of *Scyliorhinus caniculus* (L.) (J. C. van de Kamer & A. J. Schuurmans). The journal is beauti-

fully printed, and the illustrations, including the 8 plates of half-tones, are good. Inasmuch as this first issue runs to 96 pages, exclusive of the plates, it may be conjectured that a volume will contain close to 400 pages.

The names of the 24 eminent members of the Editorial Board assure the new journal of a broad international representation, although one that is predominantly European and entirely west of the Iron Curtain, as might have been expected.

TISSUE CULTURE. *The Growth and Differentiation of Normal Tissues in Artificial Media.*

By E. N. Willmer. Methuen & Company, London; John Wiley & Sons, New York. $2.25. xx + 175 pp. + 2 pl.; text ill. 1954.

Everyone concerned with tissue culture, especially students, will be glad to learn that this compact and informative little volume has been brought up-to-date and reissued in a second edition. The book is larger but not greatly so. The general approach, organization, and format remain unchanged. There is an added section on the roller-tube method so much used in larger institutions. New material on the biochemical aspects of the subject has been added, along with the relatively newer work of such investigators as Fell on the influence of vitamin A, of Spratt on the chick blastoderm, and of Medawar on the skin.

Perhaps it should be added that this is not a book of detailed instructions. For these the reader must turn to the excellent manuals of White or Cameron. There is a glossary, a bibliography of over 400 titles, and a subject index.

G. B. MOMENT

REGENERATION AND WOUND-HEALING.

By A. E. Needham. Methuen & Company, London; John Wiley & Sons, New York. $1.75. viii + 152 pp.; ill. 1952.

"Multum in parvo" well describes this handy little monograph. Equipped with a bibliography of some 550 entries and, equally important, an index, this book will prove extremely useful as an introduction to the subject for beginners and as a ready reference for workers in the field. The organization is topical rather than taxonomic. After a careful description and critical evaluation of the work on the course of normal regeneration from an anatomical point of view, Needham gives an account, with remarkably few omissions, of what is known about the physiology and biochemistry of regeneration and wound-healing. By far the longest chapter concerns the "causal analysis of regeneration." The immense and baffling complexities of the problem as it is found in a vast variety of animals spread throughout the entire animal kingdom are made abundantly clear. The work and theories of the older and of the more recent investigators are presented and evaluated.

Two minor criticisms can be made. The index would have been even more useful had it included the names of investigators. Secondly, the point of Morgan's argument about the non-adaptive character of regeneration appears to have been misunderstood. Morgan was mainly interested in arguing against the view that adaptation furnished an explanation of the mechanism of regeneration. A major criticism might be that it is virtually impossible to discuss the problem of regeneration, especially to make a causal analysis, without also discussing the general problem of development and differentiation. But to demand this would be to ask for another (and a larger) book.

G. B. MOMENT

LA GREFFE. *L'Avenir de la Science, No. 33.*

By Raoul-Michel May. Librairie Gallimard, Paris. 900 fr. (paper). 299 pp.; ill. 1952.

I have found the reading of Raoul May's *La Greffe* both enjoyable and rewarding, despite the fact that his approach, in which he has taken as his theme transplantation methods, with only secondary attention to principles elucidated by their use, is contrary to my own opinion that books (other than purely technical manuals) should be focused on problems or principles, with techniques considered only as they are pertinent to the discussion of the problem. In *La Greffe*, May has analyzed a number of experiments for which the only common denominator is the fact that transplantation methods have been employed. The experiments described are taken from several fields, e.g., embryology, endocrinology, and pathology. In general the examples have been selected wisely, the major criterion for inclusion being that the experimental results have opened further areas for research. Among the general topics considered are the following: plant grafts and chimeras, grafts of embryonic and adult tissues in the invertebrates, and in lower and higher vertebrates. A major part of the book is devoted to an analysis of the factors involved in brephoplastic transplantation, defined by May as the transplantation of embryonic tissues into adults of the same species.

On the whole, *La Greffe* is well written; and most of the examples are lucidly and thoroughly discussed. Hence the book is recommended to all biologists interested in problems of tissue interaction. The following criticisms should be noted. (1) The quality of the photographs is poor. (2) The lists of references, found at the end of each chapter, are incomplete. May frequently cites an author's name and date of publication, but believes that this information should suffice to enable the interested reader to trace the original reference. The time expended by the author in giving complete

references would have been amply rewarded by the time saved by readers who must search incompletely indexed abstract journals for the information. (3) With respect to factual content and interpretation, the treatment, in the Introduction and in Chapter 2, of the general problem of the development of species- and tissue-specificities is not altogether critical and leaves some doubt as to the author's understanding of the principles involved. For example, several lines of evidence contradict the statement (p. 12) that "même chez l'embryon . . . la greffe n'est possible qu'à l'intérieur d'une même espèce, chez les vertebrés supérieurs tout au moins." Moreover, a considerable body of evidence indicates that the tolerance of transplanted embryonic tissues by embryonic hosts is not due to a lack of antigenicity of the donor tissue, as May suggests, but is due to the inability of the host embryo to produce circulating antibody. According to the author, the embryo manifests species-specificity, but not tissue-specificity. In attempting to oversimplify a complex situation, the author is misleading when he states, "Un antagonisme contre des tissus d'espèce différente chez l'embryon devient une incompatibilité entre tissus adultes d'individus de même espèce."

JAMES D. EBERT

THE CHICK EMBRYO IN BIOLOGICAL RESEARCH. *Ann. N. Y. Acad. Sci., Vol. 55, Art. 2.*

Edited by Roy Waldo Miner. The New York Academy of Sciences, New York. $4.00. (paper). Pp. 37–344; ill. 1952.

This volume brings together a wide range of extremely useful information representing many points of views, many techniques, and many individuals. The 30 papers are all by active workers in the special fields on which they write. Thus the reader is assured not only of accuracy but of cogency as well. Each paper is followed by a selective bibliography. The conference from which these contributions emerged was chaired by M. E. Rawles and D. A. Karnofsky. The titles of the papers and the authors follow: Metabolism of the Early Embryo (N. T. Spratt, Jr.); Metabolic Patterns in Embryonic Development (M. Levy); The Differentiation of Enzymes in Relation to the Functional Activities of the Developing Embryo (F. Moog); Appearance of Tissue-Specific Proteins during Development (J. D. Ebert); Physical and Chemical Changes in the Circulating Blood (A. M. Schechtman): Studies of Muscle Development (H. Herrmann); Development of the Digestive Tube and its Derivatives (D. Rudnick); Development of the Nervous System (V. Hamburger); Functional Persistence of Embryonic Determinations in Feathers and Late Developmental Stages of Spurs (M. Juhn); Development of the Excretory System (P. Gruenwald); Adrenal Cortical-Anterior Pituitary Relationships during Embryonic Life (J. F. Case); Development of Sex-Hormone Activity of the Avian Gonad (B. H. Willier); The Genetic Control of Normal Development in the Chicken Embryo (W. Landauer); Sensitive Periods during Development (H. L. Hamilton); Vitamin Deficiencies and Antagonists (W. W. Cravens); The Effects of Some Hormones on Development (E. Zwilling); The Effects of Metals on the Chick Embryo: Toxicity and the production of Abnormalities in Development (L. P. Ridgway and D. A. Karnofsky); The Effects of Radiation on the Chick Embryo (F. J. Dixon); Endogenous Viruses in the Egg (G. E. Cottral); Growth of Viruses and Rickettsiae in the Developing Chick Embryo (H. R. Cox); The Pathological Effects of Viruses on the Chick Embryo (G. J. Buddingh); The Metabolic Interactions of Intracellular Parasites and Embryonate Eggs (D. Greiff); Modification of Viral Multiplication in the Chick Embryo (H. S. Ginsburg); Chemotherapy Trials in the Chick Embryo (I. W. McLean, Jr.); Bacterial and Mycotic Infections of the Chick Embryo (G. J. Buddingh); Membrane Growth and Function (A. L. Romanoff); Transplantation of Normal Embryonic Tissues (M. E. Rawles); Tumor Transplantation to the Chick Embryo (D. A. Kornofsky, L. P. Ridgway, and P. A. Patterson); Effects of Mouse Tumor Transplantation on to the Nervous System (R. Levi-Montalcini).

G. B. MOMENT

INTRODUCTION TO VERTEBRATE EMBRYOLOGY. *Fifth Edition.*

By Waldo Shumway and F. B. Adamstone. John Wiley & Sons, New York; Chapman & Hall, London. $6.00. x + 390 pp.; ill. 1954.

The fifth edition of Shumway's *Introdnction to Vertebrate Embryology*, which is the first revision of the text since 1942, is coauthored for the first time by F. B. Adamstone, who collaborated with Shumway earlier in the preparation of *A Laboratory Manual of Vertebrate Embryology*. The major part of the revision for this new edition was carried out by Adamstone. He has retained the major features of the fourth edition, including the effective use of the comparative approach. A few sections of the book have been strengthened in the revision; for example, the account of the early development of the chick shows considerable improvement. On the whole, however, the fifth edition does not measure up to the standard set by the fourth, for in the revision a number of errors has been added or perpetuated. Many of the mistakes are to be found in the material from the field of experimental embryology which has been added at various points throughout the text.

One of the more serious criticisms arises from the inclusion of generalizations drawn from incomplete, preliminary experiments, of which the findings have been published chiefly in abstract form, without the

data necessary for a critical evaluation of them. I refer particularly to the discussion on p. 164 relative to the hypothesis of organ-specific control of differentiation and growth, originally proposed by Paul Weiss (who still regards the idea as a tentative working hypothesis). Moreover, in presenting the ideas of Weiss, a serious error has been committed. The following statement is made: "Thus Weiss has shown that embryonic tissue explants containing a structure A will *grow* successfully in extracts made from embryos from which the structure A has been removed. By contrast, if the culture medium contains an extract of A then *growth* of this structure will be inhibited in the explant" (italics added). On the contrary, the facts are that extracts made from embryos lacking a particular structure *favor* the *differentiation* of the homologous organ, while media containing a given organ extract *favor* the *growth* of the homologous tissue.

The following additional errors should be noted: in listing important events in the history of embryology, the date for the "organizer concept" of Spemann and Mangold is given as 1934 rather than 1924, the year in which the classical paper "Über Induktion von Embryonanlagen durch Implantation artfremder Organisator" was published; Muller is misspelled as Müller; the experiments of Willier and Rawles which demonstrated the genetic control of feather color pattern are attributed incorrectly to Dushane; the authors err in stating that "Spratt has found by in vitro culture of chick embryos that glycogen is one of the substances most essential for early development," since Spratt's findings show that the explanted early embryo cannot utilize glycogen. In defining agglutination, fertilizin is described as an enzyme—has this substance been shown to have enzymatic activity? "Epiblast" is given incorrectly as a synonym for "ectoderm."

In addition, a number of statements of fact are made which are incomplete or only partially correct. Two examples from the same page: (1) "In the frog's egg artificial parthenogenesis has been produced by slightly puncturing the egg with a finely pointed glass needle." [The need for a "second factor" is not mentioned.] (2) Fertilization is indicated to be accompanied by a very great increase in oxygen uptake, a statement that is true for several species but grossly inaccurate for many others.

Other questions which may be raised include the following: Should the concept of "self-differentiation" be perpetuated? Is it correct to employ the term "organ-forming areas" so broadly as to embrace the areas described by Vogt's presumptive area maps of the amphibian gastrula and the regions of the chick embryo described on the basis of their ability to differentiate in chorio-allantoic grafts?

It is unfortunate that in this revision the terminology used in the fourth edition to indicate the degree of relationship of donor and host tissues in transplantation experiments has not been brought into line with that more widely used at present. For example, the authors use "homoplastic" in the manner in which "autoplastic" is employed today, "heteroplastic" as we use "homoplastic," and so on. Finally, chapter 17, on muscles, might have been improved materially had the authors consulted the recent comprehensive study by Straus and Rawles on the origin of the trunk musculature.

In my judgment the fifth edition of *Introduction to Vertebrate Embryology* is far less critical than the fourth edition of the same text. Hence it is not to be recommended.

JAMES D. EBERT

A LABORATORY MANUAL OF VERTEBRATE EMBRYOLOGY. *Anatomy of Selected Embryos of the Frog, Chick, and Pig. Third Edition.*

By F. B. Adamstone and Waldo Shumway. John Wiley & Sons, New York; Chapman & Hall, London. $2.50 (paper). viii + 98 pp.; ill. 1954.

Embryologists will welcome this revised edition of a neat, clearly written and well-organized manual. The authors' forte obviously is the field of developmental anatomy, for in contrast to their *Introduction to Vertebrate Embryology*, the *Laboratory Manual* is critical and precise. The most extensive revisions were made in Part I, Anatomy of Frog Embryos, which includes detailed directions for the study of 3, 6, and 11 mm. embryos. The description of the early development of the chick follows the interpretation of Spratt rather than that of Pasteels and Malan on questions of the mode of elongation of the primitive streak and location of presumptive chorda mesoderm, without indicating that any difference of opinion exists.

JAMES D. EBERT

COMPARATIVE EMBRYOLOGY OF THE VERTEBRATES.

By Olin E. Nelsen. The Blakiston Company, New York, and Toronto. $8.00. xxiii + 982 pp.; ill. 1953.

This magnum opus of Nelsen's is the first modern attempt in America at an inclusive study of the comparative embryology of vertebrates and other chordates. Roughly the first quarter of the book is devoted to a study of the reproductive system, the gametes, and fertilization; the second quarter to embryonic development from cleavage through the establishment of the primitive axial organs; and the last half principally to the histogenesis and morphogenesis of the organ-systems.

The book, which is eclectic, includes an enormous amount of highly detailed information not only about comparative embryology, which is treated primarily from a morphological point of view, but also about such cognate subjects as comparative anatomy and

histology, cytology, endocrinology, etc. The amount of data included is so extensive that in order to present it intelligibly the author has organized it very tightly, and the volume is strenuously outlined and cross-referenced, sometimes to the point of repetitiousness. The book, as a result, is not very relaxed in its writing, its construction, or its reading. But it is on the whole more than reasonably accurate, and for those who find it desirable to have so many various facts packaged within a single volume it will prove indispensable.

JANE OPPENHEIMER

HUMAN EMBRYOLOGY. *Second Edition.*

By Bradley M. Patten. The Blakiston Company, New York and Toronto. $12.00. xvii + 798 pp. 1953.

The phrases employed by Moment in describing the first edition of Patten's *Human Embryology* (*Q.R.B.*, 26: 389. 1946), namely, "well organized," "well written," and "superbly illustrated," are appropriate to the second edition as well. A large part of the book remains virtually unchanged; Chapters 4 (Cleavage, Germ Layers, and Establishment of Embryonic Body) and 6 (Fetal Membranes and Placenta) have been revised considerably to include recent findings from studies of early human embryos. Extensive changes have been made in Chapter 19, Development of the Circulatory System, reflecting not only the increased emphasis on surgical treatment of congenital cardiovascular defects, but the author's research interests as well. This chapter is exceptionally well done. The bibliography for the First Edition has been left intact, and is supplemented by an extensive listing of references covering the years 1945–1952.

In his Preface to the First Edition, Patten pointed out that he does not expect that either student or instructor will find in the book all he seeks. In my opinion, the book is deficient in only one major area, namely, in its failure to create an awareness of the interrelationships of genetics and embryology. In view of the increasingly important contributions of genetics to human developmental physiology, the sections on genetics, which even in 1946, according to Moment, had a "dated sound," should have been revised thoroughly. This has not been done. The treatment of genetics not only has a dated sound, but is so superficial that it falls below the level taught in most elementary biology courses. Apart from this criticism, the book is unexcelled in presenting the processes of human development, and is recommended highly.

JAMES D. EBERT

LA DIFFERÉNCIATION SEXUELLE HUMAINE. *Ses Incidences en Pathologie.*

By Jean Vague; Preface by Pr G. Maranon. Masson et Cie., Paris. 3,200 fr. xii + 386 pp.; ill. 1953.

This work begins with a resume of the spontaneous and experimental factors responsible for the degrees of sexual differentiation observed in animals up to and including the mammals. There is then a rather complete chapter on various aspects of sexual differentiation in the human being, including the sex manifestations, not only in regard to the primary and secondary sex organs, but also the skeleton, skin, respiratory, and other systems. The discussion of sexual types of the human being includes not only the usual groups of hermaphrodites and pseudohermaphrodites, but a host of intermediate types, such as hypergynoid and android females and males, all determined by rather minor correlations of supposed skin, skeleton, or other system tendencies to favor one sex or the other.

The main part of the book attempts correlations of abnormal sexual differentiations of this sort with various disease processes, not only of the sort ordinarily associated with differences of sex differentiation, such as adrenal hyperplasia, functioning ovarian tumors and the like, but such processes as gout, obesity, disorders of the liver, or psychiatric disorders. The whole point of these correlations is of course to direct therapy, not only at the disease in the ordinary sense of the word, but also to the psychological and other aspects of those minor degrees of intersexuality.

The critical observer will probably feel that in many instances the correlations of difficulties of sex differentiation with primary pathological processes are by means of only superficial evidence and are of only academic importance if indeed they exist. It must be said that the rather complete coverage of sex correlations for almost all human systems records data not ordinarily available and represents the strongest point in the book. This portion of the work represents a real contribution to the literature on intersexuality.

HOWARD W. JONES, JR.

ORAL INCUBATION IN TILAPIA MACROCEPHALA. *1. Embryological Studies. 2. Experimental Studies. Bull. Amer. Mus. nat. Hist., Vol. 103, Art. 5.*

(1) By Evelyn S. Shaw. (2) By Evelyn S. Shaw and Lester R. Aronson. American Museum of Natural History, New York. $1.25 (paper). Pp. 375–416 + 13 pl.; text ill. 1954.

THE IMPORTANCE OF ADEQUATE STIMULATION FOR THE CHEMICAL COMPOSITION OF RETINAL GANGLION CELLS DURING EARLY POST-NATAL DEVELOPMENT. *From the Department of Histology, Faculty of Medicine, Göteborg, Sweden. ACTA radiol. Stockh., Suppl. 96.*

By Sven-Olof Brattgård. Acta Radiologica, Stockholm. S.Kr. 20.-(paper). 80 pp.; ill. 1952.

ANIMAL MORPHOLOGY

ANATOMY AND PHYSIOLOGY LABORATORY MANUAL.
By Arthur W. Glass and Charles Hamrum. W. B. Saunders Company, Philadelphia and London. $1.50 (paper). v + 57 pp.; ill. 1953.
This lithoprinted laboratory guide for a one-semester course covers work on the Microscope, Cell, Mitosis, Study of the Tissues, Study of the Blood, Study of the Skeleton, Study of Selected Muscles, Experiments in General Physiology, Experiments in Muscle Physiology, and The Foetal Pig. The numerous diagrams, many of which are to be labeled by the student, are exceptionally clear and well drawn.

PERIODONTIA. *A Study of the Histology, Physiology, and Pathology of the Periodontium and the Treatment of Its Diseases. Third Edition.*
By Henry M. Goldman. The C. V. Mosby Company, St. Louis. $16.00. 790 pp. + 2 pl.; text ill. 1953.
This is really an encyclopedia of periodontology, beautifully printed, with a great number of fine illustrations, mostly life-size photographs or highly magnified photomicrographs. Special mention can be made of only a few of the most interesting parts of the book. In the section on reattachment, the conflicting arguments and reports are well summarized, and the author's belief in the possibility of reattachment under certain conditions is well set forth. It is in the chapters on gingivectomy and gingivoplasty and osteoplasty that the most interesting and thought-provoking material is presented, so clearly and convincingly that the reader finds it hard to remember that much of the technique described is not in general use by periodontists. The presentation is so good, however, that the reader is left with an "I could do that" feeling.
The chapter on occlusal adjustment by selective grinding is a fine presentation of the views of the proponents of this process, even for those who do not support its use. Like the two previous editions, this book is a real contribution to the literature of dentistry.

JOHN A. CAMERON

DU CRANE ANIMAL AU CRANE HUMAIN.
By A. Delattre; Préface by Prof. Vallois. Masson et Cie., Paris. 400 fr. (paper). 104 pp.; ill. 1951.
The study of cranial features assumes a very considerable importance both in systematic mammalogy and in physical anthropology. It has long been realized that for purposes of comparison, skulls must be orientated in a standard manner, e.g., in the Frankfurt horizontal, or in the plane represented by a part of the basicranial axis. In the present study, Delattre argues that when skulls are orientated in any of these usually accepted ways, a false impression is given of the contrast between different species, because in the living animals, each line is orientated in an entirely different plane. He submits that a true comparison is only given when they are orientated as in the living animal, namely, when the horizontal semicircular canal is placed horizontally.
The bulk of the monograph comprises an account of the differences observed between skulls of the carnivore, the ape, and man. According to Delattre, the occipital region of man has been rotated so that the foramen magnum comes face-downwards instead of backwards. A "new" region of the skull is then formed extending approximately from the vertex (i.e., the position of the inion of the carnivore) to the human inion by the ingrowth of the occipital, parietal, and temporal bones. At the same time, changes occur in the base of the skull, e.g., in the degree of angulation of the petrous temporal and in the flexion of the basicranial axis, whose anterior limb is elevated and the face consequently retracted. This change is in turn correlated with an elongation of the posterior nares. It is suggested that the entire complex is conditioned by man's assumption of an upright posture. The analysis, in a sense, presupposes that the skulls of carnivores and apes represent transitional stages between early mammalian forms and man. Nevertheless, there can be no doubt that Professor Delattre's studies contribute greatly to our views on the morphogenesis of the primate skull.

ERIC H. ASHTON

ANIMAL PHYSIOLOGY

THE PHYSIOLOGY OF MAN.
By L. L. Langley and E. Cheraskin. McGraw-Hill Book Company, New York, Toronto, and London. $5.50. xii + 608 pp.; ill. 1954.
This text is written in a lively style; it is replete with original and somewhat impish illustrations, and it is "dedicated to the proposition that learning can be fun." It has its usual share of errors of fact, some of which are glaring (p. 545, on insulin) and which will undoubtedly be corrected in subsequent editions. I say this inasmuch as I am quite certain this book will be popular enough among teachers who require a good elementary textbook to ensure subsequent editions. The book has certain weaknesses which the authors themselves acknowledge. For instance, it is dogmatic in spots and it includes no references. As to the latter omission, I am inclined to side with the author's opinion as to the lack of value in including references in an elementary text when 99 per cent of the students will never use them. As to the wisdom of dogmatism where there are not

sufficient basic facts, this proposition has been subject to considerable controversy in educational circles. It is true that dogmatic statements tend to be dull—but dull to whom? To the average student who wants to know just enough physiology to get by? or to those trouble-makers who continually question the wisdom of the written word—or, what is even worse, of their betters? If the latter, this book is not to be recommended, for those students will undoubtedly annoy their instructors with unanswerable questions and probably end up by writing textbooks themselves. If, on the other hand, it is not dull to the former group (the 99 per cent), then learning will be fun and teaching them won't be intolerable. This textbook is a labor of love from two obviously enthusiastic teachers. It is recommended for those who require a well-written and originally illustrated book in elementary physiology.

DAVID B. TYLER

PHYSIOLOGY. *Second Edition.*

By Rolland J. Main; revised by Alfred W. Richardson. The C. V. Mosby Company, St. Louis. $7.00. 474 pp.; ill. 1953.

This is a practically complete revision by Richardson of Main's *Physiology*. The essential feature of the first edition (*Q.R.B.* 21: 298. 1946.) is maintained, that is, this textbook is not encyclopedic, confines its treatment to abstracting the fundamental concepts of physiology, and can serve for review purposes. The emphasis again is on human physiology, with little reference to the comparative aspects of the subject. In this edition there are new chapters on the autonomic nervous system, metabolism, and renal physiology. Many subjects have been substantially revised and expanded, particularly those topics dealing with reflexes, respiration, and body fluids. Also included are an additional two dozen original illustrations which have done much to improve this text.

DAVID B. TYLER

WATER, ELECTROLYTE AND ACID-BASE BALANCE. *Normal and Pathologic Physiology as a Basis for Therapy.*

By Harry F. Weisberg. The Williams & Wilkins Company, Baltimore. $5.00. xv + 245 pp.; ill. 1953.

This monograph is a synoptic survey of the data from about 400 papers in the current literature, as they apply to clinical medicine; so it is designed principally for the physician. It is well organized, contains an extensive bibliography, and should be a valuable source book in this field.

DAVID B. TYLER

ENERGY METABOLISM AND NUTRITION.

By Raymond W. Swift and Cyrus E. French. The Scarecrow Press, Washington. $5.75. 264 pp.; ill. 1954.

This should be a valuable book for senior and graduate students of biochemistry and physiology, as well as for those who require a guide into the use of various methods of direct and indirect calorimetry. It is well written and excellently organized, and contains an adequate bibliography. The chapters on experimentation are especially good, particularly in illustrating the applications of many procedures in various fields of biochemistry and physiology. The approach is scholarly, and it is apparent that the authors have drawn on their own personal experience in teaching senior and graduate students.

DAVID B. TYLER

STANDARD VALUES IN BLOOD. *Handbook of Biological Data, Part One. AF Technical Report No. 6039, July 1951.*

Edited by Errett C. Albritton; prepared under the direction of the Committee on the Handbook of Biological Data, American Institute of Biological Sciences, The National Research Council. United States Air Force, Wright Air Development Center, Wright-Patterson Air Force Base, Dayton, Ohio; W. B. Saunders Company, Philadelphia. $4.50. ix + 199 pp.; ill. [1951]; 1952.

This work gives tables of concentration levels and other characteristics of the blood of man and animals. The headings are: Physical Properties, Coagulation Phenomena, Blood Groups, Erythrocytes and Hemoglobin, Leukocytes, Blood and Bone Marrow Cells, Water, Carbohydrate, Lipid, Protein, Amino Acids, Non-Protein Nitrogen, Phosphorus, Sulfur, Vitamins, Hormones, Enzymes, Electrolytes, Minerals, Gases, Acid-Base, Effects of Radiation and Storage, Therapeutic Agents. A large bibliography gives the source of each fact, theory, concentration, or other item presented in the tables. The indexing includes references to species. The publication of this volume suggests a welcome cooperation between government and academic research.

PAUL CRANEFIELD

CIRCULATION RESEARCH. *A Journal of the American Heart Association. Vol. 1, No. 1, January, 1953*

Carl J. Wiggers, Editor; Robert S. Alexander, Assistant Editor. Grune & Stratton, New York. Single copies, $2.00; foreign, $2.50; annual subscription, $7.50; foreign, $8.50.

This new bimonthly journal "aims to provide a medium

for bringing together basic research on the cardiovascular system from various disciplines, including biology, biochemistry, biophysics, morphology, pathology, physiology and pharmacology. Clinical research which contributes to an understanding of basic problems will be included; clinical research dealing with results which are of immediate interest and usefulness to clinicians will continue to be published in *Circulation*. . . . Review articles are not acceptable . . . In addition to regular papers, brief accounts of current research advances . . . will be published promptly in a section entitled Research in Progress."

The first issue, of 98 text pages, contains the following 14 papers: Tension and Distensibility of Carotid Sinus Wall, Pressoceptors and Blood Pressure Regulation (C. Heymans, A. L. Delaunois, & G. van den Heuvel-Heymans); Nucleotide Metabolism in Cardiac Activity, I. Methods and Initial Observations. II. Reactions in Systole (P. A. Khairallah & W. F. H. M. Mommaerts); Functional Analysis of the Vasomotor Innervation of the Dog's Hind Footpad (W. C. Randall, W. F. Alexander, J. W. Cox, & A. B. Hertzman); Local Postural Vasomotor Reflexes Arising from the Limb Veins (P. Gaskell & A. C. Burton); Fundamental Difference in the Reactivity of the Blood Vessels in Skin Compared with those in Muscle; Blood Flow Response in these Two Beds to Ischemia, and to Intra-arterial Injections of Methacholine, Epinephrine and Noradrenalin before and after Administration of Antiadrenergic Drugs (J. T. Lanier, H. D. Green, J. Hardaway, H. D. Johnson, & W. B. Donald); Hemodynamic Studies in Tricuspid Stenosis of Rheumatic Origin (M. I. Ferrer, R. M. Harvey, M. Kuschmer, D. W. Richards, Jr., & A. Cournand); Further Experimental Evidence that Pulmonary Capillary Pressures Do Not Reflect Cyclic Changes in Left Atrial Pressure —Mitral Lesions and Pulmonary Embolism (J. L. Ankeny); Effect of Blood and Saline Infusion on Ventricular End Diastolic Pressure, Stroke Work, Stroke Volume and Cardiac Output in the Open and Closed Chest Dog (T. B. Ferguson, O. W. Shadle, & D. E. Gregg); Extent of Agreement between Two Methods for Estimating Acute Directional Changes of Cardiac Stroke Index (D. F. Opdyke & M. E. Zanetti); Intrathoracic Volume Change in Relation to the Cardiopneumogram (W. F. Hamilton & E. A. Lombard); Oxygen Administration upon Ventricular Tachycardia and Blood Pressure in Animals with Acute Myocardial Infarction (A. S. Harris, R. W. Olsen, A. Estandía, & T. J. Ford, Jr.); The Lipoprotein Composition of Dog Lymph (I. H. Page, L. A. Lewis, & G. Plahl); and Prevention of Coronary Atherosclerosis by Estrogen-Androgen Administration in the Cholesterol-Fed Chick (J. Stamler, R. Pick, & L. N. Katz).

PHYSIOLOGY OF MUSCULAR ACTIVITY. *Fourth Edition.* *By Peter V. Karpovich; originally by Edward C. Schneider.* *W. B. Saunders Company, Philadelphia and London.* $3.75. xvi + 340 pp.; ill. 1953.

This book, one of the best in its field, is a fairly extensive revision of the older edition of Karpovitch and Schneider. A number of new chapters and topics have been added, particularly those dealing with nerve control of muscular activity, energy cost of various activities, reaction time of athletes, and allergic reactions to physical activities. The material is critically presented where controversial items are discussed. This edition is highly recommended for use by students of physical education.

DAVID B. TYLER

PHYSIOLOGY OF EXERCISE. *Second Edition.* *By Laurence E. Morehouse and Augustus T. Miller.* *The C. V. Mosby Company, St. Louis.* $4.75. 355 pp.; ill. 1953.

This second edition of an elementary textbook has been revised, mostly by rearrangement of the material presented in the first edition (*Q.R.B.*, 24: 68. 1949). There are some minor additions of subject matter. However, the general format and size remain the same.

DAVID B. TYLER

THE HARVEY LECTURES, SERIES XLVII. *Delivered under the Auspices of The Harvey Society of New York, 1951–1952, under the Patronage of The New York Academy of Medicine.* *By A. R. Todd, F. R. Winton, H. W. Magoun, W. Barry Wood, Jr., I. L. Chaikoff, Carroll M. Williams, Louis B. Flexner, Walter H. Seegers, and L. Zechmeister.* *Academic Press, New York.* $7.50. x + 271 pp.; ill. 1953.

The small volumes containing the collected Harvey Lectures for the period of one year are always good. They usually consist of a set of heterogeneous lectures, but a particular reader can always find one or two, or even more, of special interest. The lectures for 1951–1952, published in 1953, are no exception. Of special interest to the reviewer in this volume is a chapter on the Ascending Reticular Activating System in the Brainstem, by H. W. Magoun. Although this occupies less than twenty pages, it is an excellent summary of several years' work by the author and others. The findings discussed demonstrate an ascending reticular activating system in the central core of the brainstem that may be regarded as a subcortical center involved in the regulation of wakefulness. The influence of this reticular-activating system on the electro-cortical activity and the association of this with different states of arousal and sleep are discussed in a very interesting manner. The chapter on the development of the cerebral cortex, by Louis B. Flexner, is also of great interest, but the title is a misnomer. It represents an account of

a preliminary attempt to correlate some of the known biochemical and enzymatic changes that occur in neurons and other cells with the observed cytological or morphological changes.

The lecture by L. Zechmeister, Biochemical Studies on Chromatography, describes the basic aspects of the technique of chromatography and its application to a special problem. The use of this method to demonstrate the presence of benzpyrene and other polycyclic hydrocarbons in barnacles is of interest from the point of view of the cancer problem. The lecture on Metabolic Blocks in Carbohydrate Metabolism and Diabetes, by I. L. Chaikoff, is timely because of the great emphasis being placed on the problem of obesity. This lecture discusses lipogenesis, a major pathway in glucose metabolism, and some of the factors influencing lipogenesis in the liver.

Unfortunately, these volumes cannot be used as reference books, as they contain no index. However, anyone interested in what is happening in the outer borders of the field of advancing knowledge would do well to take these volumes from time to time and read in a systematic manner the lectures of particular interest to him.

FRANK H. J. FIGGE

LABORATORY MANUAL FOR ELEMENTARY HUMAN PHYSIOLOGY.

By Theron O. Odlaug. Wm. C. Brown Company Dubuque. $1.25 (paper). iii + 35 pp.; ill. 1952.

ANIMAL NUTRITION

ANNOTATED BIBLIOGRAPHY OF VITAMIN E, 1950 AND 1951. *Vol. II.*

Compiled by Philip L. Harris and Wilma Kujawski. National Vitamin Foundation, New York. $2.00 (paper). iv + 106 pp. 1952.

This volume contains 643 abstracts arranged under the main headings Occurrence and Distribution, Determination, Chemistry, Physiology and Pathology, Pharmacology, Nutrition and Metabolism, Medical and Therapeutic Use, and Veterinary Use. Under each main category there are subdivisions and in some cases subordinate divisions under these. There is also an Author Index.

BIOPHYSICS AND GENERAL PHYSIOLOGY

PROGRESS IN BIOPHYSICS AND BIOPHYSICAL CHEMISTRY. *Volume 3.*

Edited by J. A. V. Butler and J. T. Randall. Academic Press, New York; Pergamon Press, London. $9.50. viii + 386 pp. + 12 pl.; text ill. 1953.

The third volume in this already popular series on biophysics is up to the high standards set by the editors in the first two volumes. The subjects treated in this volume include autoradiography; polarized ultraviolet and infrared molecular spectra; microspectrometry of cells; physico-chemical properties of viruses; mechanisms of photobiological effects; ionic double layer theory applied to colloidal systems; the form and dimensions of particles in solution; and transport processes in ionic membranes. The articles on autoradiography, microspectrometry of cells, and polarized ultraviolet microspectrography are reports on relatively new techniques. Each article includes a thorough discussion of the principles, methods, limitations, and applications of the technique in question, and will serve as a valuable guide to research workers who are considering using the technique for the first time. R. D. B. Fraser's paper on the infra-red spectra of biologically important molecules points out clearly the pitfalls and problems of this recent approach to the structure of proteins, nucleic acids, and polysaccharides. As for the remaining articles, they are all more or less critical surveys of the present status of various biophysical problems. In the case of the articles on physicochemical studies on viruses and the mechanism of photobiological effects, I can only express the reaction of the interested but non-expert reader—that is, that both articles are well organized and easy to read. F. Booth's survey of recent work on the application of the theory of the ionic double layer to colloidal systems is an excellent critical review of this problem. The article by M. Sadron on Methods of Determining the Form and Dimensions of Particles in Solution is undoubtedly one of the best critical reviews of existing methods for studying the sizes and shapes of macromolecules in solution. The convenience of having such a penetrating critique of most of the methods of studying molecular morphology within the covers of a single volume make it an invaluable reference. Teorell's article on Transport Processes and Electrical Phenomena in Ionic Membranes, while adequate from the point of view of coverage, lacks the critical analysis shown in the articles by Booth and Sadron. The extended "fixed charge membrane theory" developed in this article is no improvement on the original Teorell-Meyer-Sievers theory. It remains a pseudo-thermostatic theory of an irreversible process, the diffusion potential. From the point of view of theoretical elegance an improvement in the phenomonological theory of the "fixed charge membrane" could be made by developing the theory within the framework of the thermodynamics of irreversible processes. From the point of view of understanding the mechanism and deriving numerical values for the constants appearing in the phenomenological theories, the statistical mechanical or kinetic theory treatment of the "fixed charge" model would be preferable. Aside from the scientific values of the articles themselves, this book, like the others in the series,

does much toward establishing and defining the basic disciplines and problems of biophysics.

F. D. CARLSON

THE PERMEABILITY OF NATURAL MEMBRANES. *By Hugh Davson and J. F. Danielli; foreword by E. Newton Harvey. Cambridge University Press, New York.* $6.00. xii + 365 pp.; ill. 1952.

The "second edition" of this well-known and useful book chiefly consists of a lithographic reprint of the first edition. (Q.R.B., 19: 244. 1944). At the end of some of the chapters a paragraph about recent work (through 1950) has been added. It is not likely that those owning the first edition will want to obtain this one, but it is gratifying that the book is available again after being out of print for a long period. The fact that it is very rarely seen in second-hand stores attests its value. The authors promise a completely new edition when the modern work with tracers begins to take shape.

PAUL CRANEFIELD

AN INTRODUCTION TO ELECTRONICS FOR PHYSIOLOGICAL WORKERS. *By I. C. Whitfield. MacMillan & Company, London; St. Martin's Press, New York.* $3.50. x + 236 pp.; ill. 1953.

This is an admirably lucid book which should be just what a great many biological workers are looking for. It will not tell them how to become designers or repairers of electronic apparatus, but it will help them to understand what is going on in the equipment they use, and will provide a soothing familiarity with the jargon. Using no mathematics beyond simple algebra, the author begins with explanations of Ohm's law, capacitance and inductance, the properties of electron tubes and simple amplifiers, and goes on to discuss the cathode follower, power supplies, interference, screening, discrimination, and most other topics liable to have puzzled the uninitiated. Needless to say, the absence of mathematics precludes any quantitative discussion of certain important properties of circuits containing capacitative and inductive elements, and the wide range of topics covered in 236 pages precludes any very deep treatment. But it is an easy book to follow and owes its clarity to careful thought on the author's part and to the provision of over 200 text figures—and not to careless or incorrect watering down.

PAUL CRANEFIELD

RADIATIONS AND LIVING CELLS. *An Introduction to Radiation Biology, in which the action of Penetrating Radiations on the Living Cell is described, with special reference to the Effect on Cell Division in Human Tissues. By F. G. Spear. John Wiley & Sons, New York.* $3.50. xii + 222 + 25 pl.; text ill. 1953.

If the extent of the subject which this book attempts to cover, as stated in the subtitle, be considered, it is a simple, concise, relatively small book, essentially a series of lectures rewritten and condensed to less than 60,000 words in the hope of producing a book intermediate between a popular presentation and a standard book for specialists. The work was dedicated to the Hospital Physicists' Association as a contribution toward "bridging the gap" between medical physics and radiation. The attempt to produce a book for such a group of specialists has led to the introduction of some very elementary physics. This will, however, make it easier for the beginning student, in addition to providing an opportunity to review some of the basic biophysics. The first part of the book concerns itself with the beginnings of radiation biology. The second chapter is almost entirely normal histology, and is followed by a chapter on the scope of radiation biology. The remainder of the book deals with the biological action of radiation in vitro and in vivo. The effects of radiation on the skin, blood, and generative system are covered by special chapters. Total body radiation and the relationship of radiation to cancer are also discussed. The final chapter is one on the theories concerning the mechanism of action of penetrating rays on living cells. The illustrations are rather conspicuous, because they have almost all been borrowed from standard textbooks in histology or from friends and collaborators of the author. It is, however, a very easily read, non-mathematical treatment of radiobiology. The book should make good reading for medical students, beginners in radiobiology, and others interested in radiation effects.

FRANK H. J. FIGGE

GRUNDLAGEN DER STRAHLENTHERAPIE. *Physik, Biologie und allgemeine Therapie. By Richard Kurt Kepp; foreword by Heinrich Martius. Georg Thieme Verlag, Stuttgart; (Grune & Stratton, New York).* DM. 38.00. xx + 357 pp.; ill. 1952.

This is a text on those principles of physics and biology which form the basis for radiation therapy. The first part of the book deals with radiation physics. Topics include the nature of radiation, of matter, and of their interactions. The discussion includes information about techniques in radiological physics. Some practical aspects of x-rays, radium, and radioisotopes are also mentioned.

The second part deals with radiation biology and some therapy which serves to illustrate biologic principles. As in the first part, all of the now recognized important aspects are treated. Theories and examples are given for variation in biologic effect with changes in

physical, chemical, and biologic factors. Radiation reactions of the various tissues and organs are taken up in some detail.

The concluding parts attempt to relate the physical and biologic principles previously mentioned to the many practical problems of radiotherapy. The list of references and the index appear to be, like other parts of the book, satisfactorily treated.

TITUS C. EVANS

RADIATION RESEARCH. *Official Organ of The Radiation Research Society. Volume 1, Number 1, February 1954. Managing Editor: Titus C. Evans. Academic Press, New York.* $9.00. 132 pp.; ill. 1954.

This new journal is intended "to promote the integration of the disciplines of physics, chemistry, biology, and medical research as they are concerned with the effects of radiation on matter. The term *radiation* is here used in its broadest sense. . . ." Only time will tell whether the effort to attract a wide variety of papers from different disciplines and so to secure the desired cross-fertilization is going to be successful in overcoming the established habits of submitting genetics papers to genetics journals, etc.

The new journal is beautifully printed on the highest grade of paper. It is to be issued 6 times a year, with approximately 550 pages per volume. The first issue contains the following papers: Introductory Remarks on the Dosimetry of Ionizing Radiations (U. Fano); Neutron Physics of Concern to the Biologist (Burton J. Moyer); X-Ray Dosimetry: General Principles and Experimental Factors (Leonidas D. Marinelli); Measurement of Slow Neutrons and Coexisting Radiations (P. S. Harris); Energy Requirements for the Inactivation of Bovine Serum Albumin by Radiation (Franklin Hutchinson); Molecular Product and Free Radical Yields of Ionizing Radiations in Aqueous Solutions (Edwin J. Hart); Theoretical Survey of the Radiation Chemistry of Water and Aqueous Solutions (H. A. Dewhurst, A. H. Samuel, and J. L. Magee); The Yields of Free H and OH in the Irradiation of Water (A. O. Allen); Effects of Heavy-Particle Irradiation of Aqueous Acetic Acid (W. M. Garrison, H. R. Haymond, and B. M. Weeks); The Role of Free Radicals and Oxygen in Reactions Produced by Ionizing Radiations (E. S. Guzman Barron). In addition, the abstracts of papers presented at the first annual meeting of the new Radiation Research Society and the announcement of its second annual meeting are included.

THE SCIENCE OF COLOR.

Committee on Colorimetry, Optical Society of America. Thomas Y. Crowell Company, New York. $5.50. xiv + 386 pp. + 25 pl.; text ill. 1953.

During 1920 and 1921 a Committee on Colorimetry, under the chairmanship of Dr. L. T. Troland, prepared a report which set forth a clear terminology in the field of colorimetry; summarized the available physical, psychophysical, and psychological data relating color to its stimulus conditions; outlined the principal methods of color measurement; and established the relationship between their respective scales. That report, published in the *Journal of the Optical Society of America and Review of Scientific Instruments* in August, 1922, represented the most complete and authoritative compilation of material available in the field of colorimetry at that time. It stood for many years as the outstanding reference authority in the area.

For a number of years, however, it has been apparent that the revision of the 1922 report was badly needed. As a result, in 1933 a new Committee on Colorimetry, now comprising 23 of the most distinguished names in color science, was established to undertake the revision. *The Science of Color* is the result of this new committee's work.

The volume contains 9 chapters, headed as follows: From the Art of Coloring to the Science of Color; the Concept of Color; Anatomy and Physiology of Color Vision; Psychological Concepts: Sensory Aspects of Color; Psychological Concepts: Perceptual and Affective Aspects of Color; Physical Concepts: Radiant Energy and Its Measurement; Psychophysics of Color; Quantitative Data and Methods for Colorimetry; and Colorimeters and Color Standards. There are 25 color plates, 102 black-and-white figures, 40 tables of basic colorimetric data, hundreds of references, and 20 pages of Glossary-Index. Although there are some undesirable features of this volume (for example, the references are difficult to use since they are neither listed alphabetically nor indexed), there can be no doubt that it is a basic reference volume which every visual scientist will want to have.

A. CHAPANIS

BIOCHEMISTRY

GENERAL BIOCHEMISTRY.

By Joseph S. Fruton and Sofia Simmonds. John Wiley & Sons, New York; Chapman & Hall, London. $10.00. xii + 940 pp.; ill. 1953.

In this admirable textbook biochemistry is presented as a dynamic research area which has drawn increasing numbers of scientists to its study. No attempt is made to justify biochemistry by an enumeration of agricultural and medical applications. The authors capture the readers' interest by a straightforward presentation of the substance of biochemistry.

The book emphasizes the discussion of enzyme-mediated reactions that occur in animals, plants, and microorganisms. Much information from the fields of

organic and physical chemistry is included where appropriate. At the outset, the authors present a short chapter on the scope and history of biochemistry and then launch into a general and comprehensive introduction to proteins. Enzymology, biological oxidations, and the intermediate metabolism of carbohydrates, lipids, and nitrogen compounds are discussed next in a similar manner. Perhaps the chapter on nucleic acids is too brief and should be expanded in future editions in order to encompass recent advances in this burgeoning field. In addition, the last section, which deals with inorganic ions, heat changes, hormones, and vitamins, is written more as a summary than as the well illustrated discussion which distinguishes the rest of the book. I myself have found the index to be useful but suggest further entries. For instance, there are many textual references to the enzymes of *E. coli*, but this organism is not listed in the index. It is left for the authors and publisher to reconcile comprehensiveness and portability.

The authors are to be congratulated for their painstaking separation of facts and hypotheses. Their discussions are mature, well and economically written, and illuminated by good illustrations. The references are up to date, ample, and conveniently located on the page where cited. The publishers also deserve praise for the high quality of print, paper, and reproductions. *General Biochemistry* is strongly recommended to those who wish to study biochemistry.

LAZARUS ASTRACHAN

PRINCIPLES OF BIOCHEMISTRY. *A Biological Approach. By M. V. Tracey. Pitman Publishing Corporation, New York, Toronto, and London.* $4.00. x + 194 pp. + 4 charts; text ill. 1954.

The aim of this book is to present an elementary introduction to biochemistry based on the fundamental similarities between different organisms. The introduction sets forth the advantages of such an approach, while at the same time emphasizing that apparent similarities can also mask deepseated differences, as in the case of the same enzyme obtained from different sources.

The first chapters contain a concise review of the chemical units of living organisms and basic metabolic pathways. These are presented with the aid of very illuminating schemes and diagrams. The following sections touch lightly on a very wide number of topics, with the result that the reader is exposed to most of the important aspects of biology and biochemistry in much the same fashion as the average American tourist is exposed to the treasures of the Louvre. The chapter on organizational stores, for instance, covers energetics, the properties and functions of enzymes, transfer mechanisms, coenzymes, inhibitors, and tricarboxylic acid cycle, the urea cycle, structural components, and antigens. The chapter on growth, differentiation, and reproduction is a similar catalogue of cytology, genetics, and evolution.

The second part of the book is devoted, in a similar diffuse manner, to various relationships between organisms, specialization, structure, transport, and coordination. There is also an interesting discussion of excretion, accumulation, and the function of end products.

The final section, because it confines itself to an extensive discussion of the relatively limited topic of Specialization by Energy Source, is considerably more satisfactory than the others. It is here that the comprehensive treatment of all forms of life proves helpful rather than distracting.

The manner in which all this diverse material is presented places further difficulties in the path of the reader. Many paragraphs are two pages long, and cover a number of unrelated topics which could have been presented more clearly in shorter, better defined paragraphs. There is positively no need for such obscure words as "eremacausis" in place of decay, or "armamentarium" instead of supply. The index is far too skimpy for the number of different topics touched on throughout the book.

The text, moreover, is not free from misleading statements. Thus the breakdown of fatty acids is incorrectly described as a phosphorolysis (p. 24), and the role of Coenzyme A in this process is not even mentioned, although Coenzyme A is referred to briefly elsewhere in the book. On p. 49, coenzymes I and II are described as transferring pairs of hydrogen atoms, when in actuality only one hydrogen atom is transferred, the other being released as a proton. On p. 188 the statement is made that plant viruses consist solely of ribonucleic acid. The omission of any discussion of the oxidative pathway of glycolysis in a book of this kind is also to be regretted.

This book was intended as an introduction to biochemistry for workers in related fields. As an elementary textbook it is nowhere nearly as satisfactory as Baldwin's excellent presentation. On the other hand, many specialized biochemists may well benefit from its broad sweep, refreshing ideas, and the many intriguing bits of knowledge which are scattered through its text like the currants in a bun.

L. SHUSTER

THE BIOCHEMISTRY OF THE NUCLEIC ACIDS. *Second Edition. By J. N. Davidson. Methuen & Company, London; John Wiley & Sons, New York.* $2.25. viii + 200 pp. + 4 pl.; text ill. 1953.

In spite of the paramount importance of the nucleic acids in biology, it is only recently that their bio-

chemistry has received any but scant attention in most textbooks. This little book will therefore be welcomed for its concise presentation of most of the pertinent information needed by anyone interested in the field.

The first part of the book deals with the physical and chemical properties of the nucleic acids and their measurement. Among the additions made since publication of the first edition in 1950 is a full description of the theories of the Cambridge group of investigators concerning the polynucleotide structure of ribonucleic acid. There is a review of analytical methods and the arguments over the value of histochemical tests such as the Feulgen stain. The discussion of nucleases is confined almost entirely to pancreatic ribonuclease and desoxyribonuclease. While both these enzymes have been crystallized and studied extensively, mention of the other nucleases which have been described in a wide number of natural materials could have given a more satisfactory general picture.

The last half of the book deals with the relationships of the nucleic acids to the living organism. Data on the occurrence and composition of nucleic acids in various tissues are presented, together with a discussion of cellular and chromosomal structure. The degradative metabolism of nucleic acids is described in the usual terms of comparative biochemistry. Much of the recent data obtained with isotopically labelled precursors is incorporated in the chapter on biosynthesis.

The biological activity of nucleic acids is considered chiefly in terms of turnover rates. There is also an interesting discussion of experiments on the relation of nucleic acids to protein synthesis and differentiation. In Chapter 15, the intermediate in the synthesis of hippuric acid is erroneously described as a phosphorylated benzoic acid rather than a Coenzyme A derivative. The final chapter, on nucleic acids in microorganisms, deals with bacterial transformations and recent work on viruses.

The book is very well documented throughout, and the reader is constantly referred to extensive reviews on any topics which receive but cursory attention. The author's approach is vigorous and unpretentious. This little volume should prove very helpful to any investigator preparing to set forth on one of the most ambitious undertakings of the century—the conquest of the nucleus.

L. Shuster

Practical Methods in Biochemistry. *Sixth Edition.*

By Frederick C. Koch and Martin E. Hanke. The Williams & Wilkins Company, Baltimore. $5.00. x + 537 pp.; ill. 1953.

In this sixth edition of a standard laboratory course in biochemistry for medical students, various new preparations and procedures have been included, such as the preparations of crystalline egg albumen and of cytochrome c. Some new elementary enzyme studies are a welcome addition. There is a remarkably extensive chapter devoted to the uses of the Van Slyke apparatus in manometric work, although no experiments making use of the Warburg apparatus are to be found in the book.

A. T. Jagendorf

Chromatographic Methods of Inorganic Analysis *with Special Reference to Paper Chromatography. By F. H. Pollard and J. F. W. McOmie. Academic Press, New York; (Butterworths Scientific Publications, London).* $5.50. viii + 192 pp. + 3 pl.; text ill. 1953.

This book gives a thorough account of the methods of using filter paper, cellulose, and other adsorbents in the analysis of inorganic compounds. Most of the volume deals with the qualitative detection of anions and cations, but one chapter gives complete directions for a number of quantitative analyses. The book stresses the practical aspects of inorganic analysis and gives detailed directions for preparing various solvent mixtures and methods of detecting the position of the inorganic compounds on filter paper or on columns. It is evident that the authors have had a wide experience in chromatographic problems, and many of the separations discussed in the book are based on their own procedures. Biologists will find a great deal of worth-while material in this book.

G. R. Noggle

Ion Exchange Resins in Medicine and Biological Research. *Ann. N. Y. Acad. Sci., Vol. 57, Art. 3. Editor, Roy Waldo Miner; Conference Chairmen: H. Sobotka and H. P. Gregor; Consulting Editor: Harry Sobotka. New York Academy of Sciences, New York.* $4.50 (paper). Pp. 61–324; ill. 1953.

This volume contains papers presented at a conference on Ion Exchange Resins in Medicine and Biological Research held by the Sections of Biology and of Physics and Chemistry of the New York Academy of Sciences. The first 9 papers cover the theoretical aspects of ion exchange, the synthesis of ion exchange resins, and certain related topics. Of especial interest is a paper on electron exchange polymers, a class of resins that will certainly be of wide interest to biologists. The balance of the papers consider the application of ion exchange resins to biological and medical problems. One paper is devoted to the use of resins in separating amino acids, nucleic acid derivatives, sugars, and other biological

materials. The others deal with the therapeutic use of ion exchange resins and some diagnostic applications. The book is not a laboratory manual but rather a series of research reports and reviews. The papers are all well written and can be recommended to all biologists and medical men who wish to inform themselves about the uses of ion exchange resins as a research tool or as a clinical tool.

G. R. NOGGLE

ORGANIC SYNTHESES. *Volume 32.*

Richard T. Arnold, Editor-in-Chief. John Wiley & Sons; Chapman & Hall, London. $3.50. vi + 119 pp.; ill. 1952.

This volume presents detailed procedures for the preparation of 43 organic compounds. Some of the compounds of biological or biochemical interest are: abietic acid, alloxan monohydrate, ϵ-aminocaproic acid, 1-chloro-2,6-dinitrobenzene, 3-cyano-6-methyl-2(1)-pyridone, 4,6-dimethylcoumalin *asym*-dimethylurea, isodehydroacetic acid, methyl glyoxal-ω-phenyl hydrazone, and phenylacetamide. The subject index is cumulative and comprises material from volumes 30, 31, and 32.

BIOCHEMICAL PREPARATIONS. *Volume 3.*

Editor-in-Chief, Esmond E. Snell. John Wiley & Sons, New York; Chapman & Hall, London. $3.50. viii + 127 pp.; ill. 1953.

This volume contains detailed procedures describing the preparation of 2 crystalline enzymes—muscle phosphorylase and ribonuclease; 4 coenzymes—diphosphopyridine nucleotide, triphosphopyridine nucleotide, pyridoxal phosphate, and pyridoxamine phosphate; and 18 compounds of biological and biochemical interest—protoporphorine dimethyl ester, *d*-isocitric acid, *dl*-isocitric acid lactone, dihydroxyfumaric acid, oxalacetic acid, L(+) and D(−) lactic acids, sodium α-ketoisocaproate, D-glucose-6-phosphoric acid, D-galacturonic acid, β-2,5-dihydroxyphenyl-DL-alanine, L- and D-isoleucine, L- and D-alloisoleucine, L- and DL-ornithine monohydrochlorides, L- and DL-citrulline, L-kynurenine, L- and D-penicillamine hydrochlorides, elaidic acid, and 2,4-dinitrofluorobenzene.

All of the preparations presented have been checked for accuracy and reproducibility by several laboratories, as was the practice for the preceding volumes. The subject index is cumulative and comprises material from volumes 1, 2, and 3. A list of compounds of biological interest, whose preparations have been described in *Organic Syntheses* through volume 32, is also included.

MICROBIOLOGY

GENERAL VIROLOGY.

By S. E. Luria. John Wiley & Sons, New York; Chapman & Hall, London. $8.50. xiv + 427 pp.; ill. 1953.

Our ideas about the tiny intracellular parasites otherwise known as filterable viruses are changing rapidly. These agents formerly were defined in a negative sense, as infectious agents incapable of growth on non-living media, small enough to be filtered through a procelain filter, and frequently producing certain "inclusions" within the cell. Today there is an insistent question: How do they grow? How do they replicate? How do they derive their energy? The question is the same, but it is phrased differently by the pathologist, the bacteriologist, the geneticist, and the chemist, all of whom now claim a special interest in viruses.

Until now there has been no volume dealing with viruses from a general biological point of view. To write this text on *General* Virology was no doubt a considerable challenge, for our ideas and terminology are confused. Luria has performed a much needed task, and in his usual lucid style. This book is a classic and marks real progress.

It is understandable that the accumulation of data from many diverse fields would cause difficulties. Some of these are in the use of words. For example, to speak of "hypersensitivity" (p. 22) in relation to an extreme necrotic reaction on the part of a plant will startle the immuno-pathologist. Other difficulties lie in the realm of ideas. The description of the infection of mice by lymphocytic chorio-meningitis (p. 38) gives a biased impression. It is indicated that an acute enzootic progressed to a situation where the virus became so beautifully adapted to the colony that the "virus passes through the placenta and may even be propagated through the egg." The studies on the Rockefeller Institute mouse colony did demonstrate that this infection may be difficult to detect in a colony, and the virus may well pass through the placenta, but not that "it is difficult to distinguish the virus from a normal cell component."

There is a minimum of scattered errors in printing and references. The book is well put together, clearly arranged, and should be available wherever studies of intracellular agents are undertaken. It should stimulate more research and teaching of general virology. What more can a book do?

FREDERIK B. BANG

AN INTRODUCTION TO LABORATORY TECHNIQUE IN BACTERIOLOGY. *Third Edition.*

By Max Levine. The MacMillan Company, New York. $4.50. xviii + 413 pp. + 2 pl. + 1 chart; text ill. 1954.

The two earlier editions of this text appeared in 1927 and 1933. The book is planned as the basis for an extensive and comprehensive laboratory course in bacteriology. It contains 122 laboratory exercises, 85 of which emphasize fundamental concepts while 37 deal with food and sanitary bacteriology. Some attention is given to yeasts and other non-bacterial microorganisms. Brief lists of references follow most of the exercises. The journal references are few but adequate. It might have been better if dates and editions were given for some of the textbooks cited. Appendices give keys to the identification of species as well as other useful information. The book is well printed and well organized. It has many points of superiority over most beginning texts, and merits careful consideration by those giving extensive elementary courses in bacteriology.

WALTER C. TOBIE

SALMONELLAE AND SHIGELLAE. *Laboratory Diagnosis Correlated with Clinical Manifestations and Epidemiology.*

By Alfred J. Weil and Ivan Saphra. Charles C Thomas, Springfield, Ill. $7.75. xiv + 247 pp.; ill. 1953.

The writers make readily available in this volume much of the information required for the laboratory worker who is engaged in the isolation and identification of enteric pathogens. The text deals primarily with the biological and immunological properties of the organisms and the methods used in their isolation and identification. Sections on clinical features, epidemiology, and therapy are also included. The sections dealing with the immunologic basis of classification of these groups of organisms are particularly well done, and the addition of a section on reporting is well advised in the text of this type.

Some of the defects of this text would appear to be the neglect of the data regarding transmission of shigellae by the fly, the confusion in the description of the rectal swab suggested with that of the N.I.H. swab and the implied limitation of its usefulness, and the poor color plate. The statement that "perhaps as many as 10% of [untreated shigella infections] may develop . . . chronic ulcerative colitis" may be questioned by some, as well as the statement regarding the general efficacy of active immunization against *S. typhi* and *S. paratyphi* A and B without qualification. However, regardless of the above minor criticisms, this book may be recommended as a clear and concise treatment of the salmonellae and shigellae. This book is intended primarily for the hospital bacteriologist, although it would appear to be useful to general bacteriologists, physicians, medical students, and laboratory technicians as well.

PAUL F. WEHRLE

THE LITERATURE ON STREPTOMYCIN, 1944–1952.

By Selman A. Waksman. Rutgers University Press, New Brunswick. $5.00. xii + 553 pp. 1952.

This book gives 43 references on *Streptomyces* and streptothricin (pp. 1–4), and 5550 numbered references on streptomycin (pp. 5–440). The references are mainly to journal articles, but books, pamphlets, patients, and other material are also included. Unfortunately, the numbered references are given in no order at all except a very rough chronological one, with many inconsistencies. Reference No. 1 is of 1944, while the penultimate reference (No. 5549) is dated 1952. However, references Nos. 26 and 5489 are both dated 1948.

The book is loaded with all sorts of errors and inaccuracies. For example, one paper (reference 583) has "Dumanis, A. A." as an author, but in the author index the same person is rendered as "Dumanis, A. S." The author "Puntigam, F." appears as "Punticam, F." in the author index; and a contribution by "Bormioli" is attributed in the author index to "Bormidi."

The subject index is also very unsatisfactory. Reference 3080 deals with experimental pseudotuberculosis in the guinea pig, but in the subject index there is no entry either under "pseudotuberculosis" or under "guinea pig." On p. 523 there is an entry "Guinea pig tuberculosis, *See* Tuberculosis, guinea pig"; but the latter entry could not be found. Under "Tuberculosis, experimental, in guinea pigs" only 5 references appeared (despite dozens of papers which have appeared on the subject), and reference No. 3080 was not among them.

Having prepared a considerable number of bibliographies myself, I know from experience what a wearing job it is. However, one fundamental rule is that references should be in some sort of order. In most cases, the best arrangement is a strict alphabetical order of "senior" authors (i.e., the names of the persons whose names appear first on the papers). If this is done, the preparation of an author index is vastly easier, and in some cases can be omitted altogether; or, in other cases, the author index can be limited to "junior" authors whose names do not come first.

A mass of bricks and lumber piled in a heap does not make a house. The present hodge-podge of poorly indexed references does not constitute a satisfactory reference work on streptomycin. Accordingly, the book cannot be recommended. At best, it may serve as a starting-place for anyone who wants to do the work all over again.

WALTER C. TOBIE

NEOMYCIN. *Nature, Formation, Isolation, and Practical Application.*

By Selman A. Waksman, with the collaboration of 15 others. Rutgers University Press, New Brunswick. $4.00. xiv + 219 pp. + 1 pl.; text ill. 1953.

This is probably the most complete monograph to date

on the antibiotic neomycin, isolated by Waksman and his coworkers in 1949 from a strain of *Streptomyces fradiae*. In preparing the work, the author had the assistance of 15 collaborators, whose names are listed on the title page. Both clinical and experimental laboratory work are extensively considered. It is mentioned that "neomycin appears to occupy a minor but unique and definite place in the field of antibiotic therapy." It is perhaps too early to judge its main fields of usefulness. So far, its widest clinical application has been for topical use in skin infections, although there are a considerable number of other uses.

The weakest part of the work is the bibliography of 224 references, which are not in alphabetical, chronological, or any other sort of order, not even the order in which the references are cited in the text. This illogical arrangement greatly diminishes the usefulnes of the book as a reference work, since there is no separate author index which might serve as a guide to the references. On the other hand, the subject index seems adequate.

WALTER C. TOBIE

PARASITOLOGY

A GUIDE TO HUMAN PARASITOLOGY *for Medical Practitioners. Fifth Edition.*

By D. B. Blacklock and T. Southwell; revised by T. H. Davey. The Williams & Wilkins Company, Baltimore. $5.50. viii + 228 pp. + 4 pl.; text ill. 1953.

The present edition of this well-known textbook in parasitology by Blacklock and Southwell has been revised by T. H. Davey, who has much in common with the senior author. They have both directed the Sir Alfred Jones Laboratory, Freetown, W. Africa. Dr. Davey now occupies the position of Professor of Tropical Hygiene, Liverpool School of Tropical Medicine, formerly held by Dr. Blacklock.

The book has the same general appearance as earlier editions—concise descriptive text, clear line drawings, and orderly tables, but it has been brought up to date with new knowledge gathered after the second world war. It retains the spirochetes, but continues to omit the parasitic arthropods. There is no mention of toxoplasmosis, even in the chapter on congenital infections.

The 3 new color plates are very good and are improvements over the two of the earlier edition. The numerous tables at the end of the book have been omitted without serious loss. Much of the information is now contained in sections of each chapter devoted to prevention. All in all, *A Guide to Human Parasitology* should continue to fill admirably the purpose for which it was originally intended—a book for practitioners which presents "the salient characters of the common pathogenic parasites of man."

M. M. BROOKE

PARASITOLOGY (1949–1950).

By Juan Enrique Mackinnon; in collaboration with Samuel Barnsley Pessôa, Félix Pifano, and Alfonso Trejos. UNESCO Science Cooperation Office for Latin America, Montevideo. (Paper.) 287 pp.

The UNESCO Science Cooperation Office for Latin America has undertaken a series of publications to make better known the Latin American contributions to scientific progress. The present one, as the previous two on chemistry and mathematics, has been prepared as a cooperative project of a group of specialists (an author and 3 collaborators). This has been done in each case to insure completeness of coverage and accuracy.

The authors have adopted a broad interpretation of "parasitology" and have analyzed all publications which bear on any parasite or on parasitic complaints. The reviews are organized according to subject matter, with sections devoted to protozoa, arthropoda, helminths, and fungi. A thorough review of the literature has obviously been made, for there is a bibliography of 36 pages listing over 600 authors and several times that number of articles. The reviews are well written, presenting essential data as well as conclusions of investigators. There is not any author or subject index, but a rather detailed table of contents.

In view of the great amount of parasitological work that is done in Latin America, it is a real service to have it summarized in a single English publication, even though for only a couple of years. It is sincerely to be hoped that similar publications will continue to appear and to summarize the work in this field for succeeding years.

M. M. BROOKE

HEALTH AND DISEASE

ELEVEN BLUE MEN, *and Other Narratives of Medical Detection.*

By Berton Roueché. Little, Brown & Company, Boston. $3.50. iv + 215 pp. 1953.

The days of a public health officer are filled with routine checks, reports, and statistics. Occasionally a case will arise involving the elements of unusual danger or intriguing mystery. Such cases can be every bit as fascinating as their counterparts from police records. *Eleven Blue Men* is a compilation of a dozen such cases from the files of the Public Health Service of New York City.

As could be expected from their previous appearance in the *New Yorker* magazine, the stories are all eminently readable. All the elements of a good murder mystery are included—danger, secrecy, detectives, victims, clues, and even criminals. Background material, such as the description of botulism or of leprosy, is presented concisely and in an interesting manner.

The title story concerns eleven elderly Bowery vagrants who sickened and turned blue one morning in September, 1944. Their strange malady was finally graced to poisoning by sodium nitrite, a wartime substitute for saltpetre, which had inadvertently been added in place of salt to a batch of restaurant oatmeal. But why just those eleven men, out of all who had eaten oatmeal in the restaurant that morning? It was probably because, being alcoholics, their blood was low in sodium chloride, and the salt shaker which they used so liberally also contained sodium nitrite.

The book is full of fascinating information, from a sprightly history of gout to the discovery of psittacosis in ducks. All in all, this is science reporting at its best—accurate, instructive, and very enjoyable.

L. Shuster

Methods in Medical Research. *Volume 5.* *A. C. Corcoran, Editor-in-Chief; Lyman C. Craig, A. C. Corcoran, and Melvin Cohn, editors. The Year Book Publishers, Chicago.* $7.50. xiii + 394 pp.; ill. 1952.

This volume, the 5th in a series, should be on the bookshelf of anyone engaged or contemplating research in the fields covered. A very large amount of material is presented clearly and concisely in relatively few pages due to the method of organization.

Of the three sections in this volume, Section I, Methods for Separation of Complex Mixtures and Higher Molecular Weight Substances, is presented in four subsections by as many authors, under the coordination of Associate Editor Lyman C. Craig.

Section II, methods of Renal Study, presents 26 articles by nearly as many experts, all of which are ably integrated by Associate Editor A. C. Corcoran.

Section III, Immunochemical Methods for Determining Homogeneity of Proteins and Polysaccharides, has two articles by Associate Editor Melvin Cohn and two by other contributors.

A good feature of the volume is the practice of having each article reviewed by another person acquainted with the field; the reviewer's comments, if any, are included. Altogether, 56 scientists have contributed to the three sections.

The articles are a happy combination of the theory of the methods and reasonably detailed instructions for carrying them out. Illustrations are used freely and to good effect. There is a clear table of contents, and individual chapters or subsections are adequately documented (a few omit the titles of the scientific articles given as references). The detailed subject index, and the separate name index appearing at the end might be a little easier to use if the order were reversed.

The volume is highly recommended. Question: would the economics of publication permit each section to be published separately, perhaps in paper covers, for persons who need less than the complete volume or series?

Paul A. Lembcke

Textbook of Preventive Medicine. *By Hugh Rodman Leavell and E. Gurney Clark; with the collaboration of George F. Badger, Charles M. Carpenter, John M. Chapman, Paul R. David, William L. Fleming, Lloyd Florio, Lenor S. Goerke, Ernest M. Gruenberg, Edward M. Holmes, Jr., James C. McCullough, John J. Phair, L. E. Powers, Frank Princi, Milton I. Roemer, Howard A. Rusk, Robert E. Shank, Laurence H. Snyder, Jess B. Spielholz, and Myron E. Wegman. McGraw-Hill Book Company, New York, Toronto, and London.* $8.00. xviii + 629 pp.; ill. 1953.

This book, written primarily for medical students, is an important step toward a better understanding and better teaching of preventive medicine. Its objectives are to expand the concept of preventive medicine and to explain the principles on which it rests. It aims to establish preventive aspects firmly within the structure of medicine as this will be practiced by future graduates, and to promote an intelligent cooperation of physicians with other workers and agencies in the broad field of physical, mental, and social health.

The most interesting and important parts of the book are the 242 pages in which Leavell and Clark describe the aims, methods, and resources, and their personal philosophy of preventive medicine. Leavell's chapters on the Doctor and His Community (142 pp.), and Provisions for Meeting Basic Needs in the Community, are particularly good. In its present form the book is too long and varied to be read through by students, and it is possible that the basic philosophies and methodologies will elude them when it is sampled as a textbook. The authors should consider the publication, in addition to this volume, of a work of about one-third the length, limited to the fundamentals mentioned above.

Twelve chapters by 19 collaborators cover preventive medicine in relation to infectious disease, nutrition, long-term illness and aging, cancer, heredity, maternal and child health, mental health, occupational health, medical practice generally, rehabilitation, case-finding by multi-test screening, and miscellaneous conditions such as allergy, tonsillectomy, sight and hearing, and dental health. A short chapter on biostatistics is included. The philosophies and attitudes of the editors are strongly felt in most of these chapters, which conform as closely as possible to a basic pattern for presentation.

The only real flaw in this book is an inadequate table of contents that, by giving only chapter headings, limits the usefulness of a book with long chapters of such varied content. The text is well-documented and in-

dexed, and is attractively printed. It will be very useful in teaching preventive medicine.

PAUL A. LEMBCKE

KWASHIORKOR IN AFRICA. *World Health Org., Monogr. Ser. No. 8.*

By J. F. Brock and M. Autret. World Health Organization, Geneva. $1.00 (paper). 78 pp.; ill. 1952.

Representative of the excellent monographs of the World Health Organization is this report of a survey of kwashiorkor in central and tropical Africa. The syndrome is not precisely defined at present, but is a nutritional disease characterized in general by retarded growth during infancy, alterations in the pigmentation of skin and hair, fatty infiltration, cellular necrosis, or fibrosis of the liver; edema; frequent association with dermatoses; and a heavy mortality if not properly corrected by dietary measures. Kwashiorkor was encountered in every region of Africa surveyed, from Egypt to South Africa, but varies greatly in incidence according to the characteristic diet of the native peoples. It is high among tribes which subsist largely on cassava, plaintains, yams, and maize; but is restricted among those that eat reasonable quantities of animal or vegetable protein. Prevention measures should include the production of high-protein foods; storage of food to provide an adequate diet throughout the year; education of mothers; and development of a demonstration area. Although adult cirrhosis and primary carcinoma of the liver are also attributable in the main to protein deficiencies, they appear not to be directly related to kwashiorkor, which is most common among infants and young children under four years of age.

JOURNAL OF FORENSIC MEDICINE. *Vol. 1: No. 1. July–September, 1953.*

Editor, H. A. Shapiro. Published quarterly by Juta & Company, Cape Town. 12s. 6d., per copy; annual subscription, 42s. (1) 64 pp.; ill. 1953.

This new journal, sponsored by the Medico-Legal Society of Johannesburg, is addressed primarily to medical practitioners, especially those in rural areas, and will attempt to cover the medico-legal field of comprehensively. It will "devote its pages to case reports, reviews, abstracts, medico-legal news and the publication of original research work in this increasingly important branch of knowledge and practice."

The first issue contains the following articles: Blood Groups and Skin Colour (M. Shapiro); Identification of Skeletal Remains (I. Prinsloo); Dentures and Individual Identification (E. O. K. Harwood); Sudden or Unexpected Deaths in Infancy (K. M. Bowden); X-Rays in Medico-Legal Investigation (T. Addison Morgan & M. C. Harris); Sudden Death with Minimal Anatomical Findings (L. Adelson); Estimation of Stature from the Long Bones (E. N. Keen); Estimation of Age from Cranial Suture Closure (R. Singer). In addition, there are sections of Reviews of Books, and Medico-Legal Notes and News. It seems obvious, from these interesting contents, that the journal will be of value not only to medical practitioners but to a much wider audience: physical anthropologists, human geneticists, serologists, anatomists, and, of course, writers of detective stories.

BENTLEY GLASS

INFLUENZA AND OTHER INFECTIONS OF THE RESPIRATORY TRACT.

By C. H. Stuart-Harris; foreword by C. H. Andrewes. Edward Arnold & Company, London; [The Williams & Wilkins Company, Baltimore]. $6.00. iv + 235 pp.; ill. 1953.

Not only influenza, but other virus infections of the respiratory tract—Q fever, psittacosis and ornithosis, the common cold, primary atypical pneumonia, and the undifferentiated acute respiratory diseases—are dealt with competently in this volume by the University of Sheffield's professor of medicine. Stuart-Harris is experienced in both laboratory and clinical aspects of influenza, and writes authoritatively from his own wide experience as well as that of others. His background has contributed to a coverage of the laboratory aspects in a manner neither too difficult for the clinician nor too rudimentary for the laboratory investigator, and the clinical sections are suitable alike for those with only basic scientific knowledge and those practicing medicine.

The clear, authoritative style makes the reader feel confident that the great body of scientific findings pertaining to influenza has been expertly evaluated by the author. Medical practitioners and students will be the chief beneficiaries of this work, but public health workers and medical scientists in general will find it useful for orientation and reference. The bibliography is complete, and there is a good index. The style is easy, the text is enriched by many good photographs and figures, and the typography is excellent. This will be a welcome addition to medical and scientific libraries.

PAUL A. LEMBCKE

PNEUMOCONIOSIS ABSTRACTS. *Volume 1.*

Reprinted from the Bulletin of Hygiene for the years 1926 to 1938 inclusive, by permission of The Honorary Managing Committee of the Bureau of Hygiene and Tropical Diseases. Pitman Publishing Corporation,

New York, Toronto, and London. $12.50. x + 347 pp.; ill. 1953.

This is the first of two volumes intended to cover the literature on pneumoconiosis from 1926 through 1950. The subject is defined as "all forms of pulmonary reaction to inhaled dust, with no implication as to character, severity or effect on function"; although more narrowly, it is "a disease of the lungs produced by inhalation of dust. . . ." The abstracts are grouped into 12 sections: General; Silicosis; Asbestosis; Pneumoconiosis of Coal Workers; Pneumoconiosis Caused by other Inorganic Dust; Pneumoconiosis Caused by Dusts of Vegetable Origin; Fumes Causing Respiratory Disease; Sampling and Measurement of Atmospheric Dusts and Studies of their Physical, Mineralogical and Chemical Properties; Methods of Suppression and Removal of Dust, and Personal Respiratory Protection; Periodical Reports Related to Pneumoconiosis; Legislation on Pneumoconiosis; and Book Reviews. The well-printed volume also contains both author and subject indexes.

THE INCIDENCE OF PEPTIC ULCER IN DENMARK. *A Statistical Study on the Clinical Incidence of Gastric and Duodenal Ulcer in the Danish Population in 1940 and 1948.*

By Gunnar Alsted; prefaces by Johns. Frandsen and E. Meulengracht. Danish Science Press, Copenhagen. $2.25. xii + 92 pp.; ill. 1953.

Determination of the prevalence of disease in the general population by questionnaire surveys of physicians is beset with errors. Among the many causes of under-enumeration are incomplete returns of questionnaires by physicians, lack of data on the unknown and variable proportion of the population that does not seek medical care, the failure of some physicians to maintain adequate records, and a survey period so short as to eliminate patients who visit the physician at greater intervals. Either too few or too many cases may be recorded because certain patients are seen by more than one physician, because the period of the survey corresponds with either a high or low prevalence of disease, because of incorrect diagnosis, and because of failure of physicians to observe strictly the limits of the survey period. It is possible also that some doctors may over-report or under-report for reasons of prestige, economic conditions, etc.

If there is any place in the world where such errors can be minimized, it is in Denmark, where a homogeneous population of 4 million is served by about 4,000 well-educated physicians accustomed to reporting freely on the details of their practice, and where more than 90 per cent of the people have access to unlimited medical attention through compulsory sickness insurance. Nation-wide surveys were made for the months of October, 1940, and October, 1948, by methods essentially the same except that the 1940 questionnaires were distributed at the end of the month, while in 1948 they were distributed in advance. The changed procedure, rather than the intervening occupation by the Germans and postwar tensions, may account for the apparent increase in peptic ulcer from 11 to 17 per 10,000. The ill-defined condition termed "gastroduodenitis" accounts for 24 per cent of total ulcer cases. Rates are presented for age, sex, occupation, residence, location and type of ulcer, hemorrhage and perforation, and annual incidence. Curiously, the author does not show the proportion confirmed by x-ray, or the incidence of hospitalization, although both are called for by the questionnaire. Duration and recurrence are not dealt with, and the etiology remains obscure. This is an interesting and valuable work, within the noted limitations on scope and method. The report is in flawless English, beautifully printed.

PAUL A. LEMBCKE

METABOLIC AND TOXIC DISEASES OF THE NERVOUS SYSTEM. *Proc. Ass. Res. Nerv. Dis., Vol. 32.*

Edited by H. Houston Merritt and Clarence C. Hare. The Williams & Wilkins Company, Baltimore. $10.00. xii + 604 pp.; ill. 1953.

This volume contains a collection of papers presented at the Proceedings of the Association for Research in Nervous and Mental Disease held in New York on December 12 and 13, 1952. Some 45 investigators contributed 28 articles. A number of them are of sufficient excellence to make the volume of interest to students in this field. I personally found the articles of Himwich (Hypoglycemia and Brain Metabolism), Nurnberger (Clinical and Metabolic Effects of Exposure to Low Environmental Temperature on the Central Nervous System and Related Visceral Structures), and Mirsky (Carbohydrate Metabolism and Diseases of the Nervous System) exceptionally well prepared.

DAVID B. TYLER

POLIOMYELITIS.

By W. Ritchie Russell. Edward Arnold & Company, London; [The Williams & Wilkins Company, Baltimore.] $3.00. viii + 84 pp.; ill. 1952.

The author, a prominent neurologist, has attempted to summarize the clinical features, diagnosis, and treatment of poliomyelitis in this small volume, and has succeeded remarkably well. One of the chief purposes of the writer is to describe some simple objective methods of muscle strength evaluation and show how they may be used in determining the return of muscle function

during convalescence in the evaluation of various methods of therapy.

There would appear to be little proof at this time that "several strains of the virus . . . occur in [both human and] animal [mammalian] communities" other than under exceptional circumstances, and the suggestion for the management of a boarding school outbreak may be misinterpreted as a recommendation for the return of all children to their homes upon recognition of a case in the school. The omission of any mention of parenteral fluid therapy and the use of tube feeding in the acute bulbar patient may be questioned, as well as the very conservative attitude toward tracheotomy. The extremely limited discussion of differential diagnosis and spinal fluid findings could have been expanded somewhat. The emphasis on the importance of rest during the acute stages of the disease, the use of home care for selected patients, and the rational approach toward rehabilitation represent some of the positive features of this volume.

PAUL F. WEHRLE

POLIOMYELITIS. *Papers and Discussions Presented at the Second International Poliomyelitis Conference. Compiled and edited for the International Poliomyelitis Congress. J. B. Lippincott, Philadelphia, London, and Montreal.* $7.50. xxii + 555 pp. + 1 pl.; text ill. 1952.

This volume makes available the papers and discussions presented at the second International Poliomyelitis Conference held in Copenhagen in 1951. These conferences were widely attended and record the current approaches toward the problem of poliomyelitis by prominent investigators from many countries.

The scope of the volume is extremely broad and is divided into 7 major sections. These include sections on virus and its interaction with the host cell, the Coxsackie group of viruses, and the pathology, pathophysiology, diagnosis, and treatment of poliomyelitis, as well as on rehabilitation, ecology, and immunogenesis. A well-illustrated section dealing with the exhibits presented at the conference is also included. Although the majority of the volume is devoted to poliomyelitis, some information is included regarding phage, plant viruses, and the Coxsackie group of viruses. The discussions of the various papers are also included and add considerably to the value of the volume.

This book is indispensable for the reference library and all hospital libraries. While its greatest usefulness is for those physicians and researchers working chiefly with poliomyelitis, it would also be of value to health officers, general practitioners, internists, pediatricians, and orthopedic surgeons. This book can be heartily recommended as a current summation of the progress in this fast-moving field.

PAUL F. WEHRLE

THE MECHANISMS OF DISEASE. *A Study of the Autonomic Nervous System, the Endocrine System and the Electrolytes in their Relationship to Clinical Medicine. By Joseph Stambul; Foreword by George Morris Piersol. Froben Press, New York.* $15.00. xxxiii + 746 pp. 1952.

The purpose of this book, the author says, is to interpret disease in terms of altered function of the cell, or groups of like cells, rather than man as a whole or his constituent organs and fluids. He contends that, "in disease, the membrane is the first structure of the cell to lose its normal function; its permeability is increased and vital chemical components from the cytoplasm are lost into the circulation accompanied by alteration in the chemical balance of the cell and its environment, and by changes in its structure." It is claimed that acceptance of these views will lead to a better understanding of disease and a more rational approach to treatment.

Unfortunately, the book does not succeed in its aim. Changes in cells and their membranes due to a variety of physical and chemical agents are facts, of course, but the arguments for altered permeability of the cell membrane as the basic pathologic lesion in all kinds of disease are extreme and one-sided and do not take all pertinent facts into account. The concept seems loosely drawn and biased, and rests only on brief, uncritical citations from text-books and scientific articles, many of which date back 20 years or more and have since been modified by improved methods of investigation. Perhaps the greatest shortcoming is the absence of any data collected or verified by the author. One cannot reasonably expect a writer to test personally all of the hypotheses he presents, but in a medical volume such as this, it seems strange indeed that the author, a practicing physician and head of the cardiology division of a large hospital, has not tested any of the procedures that he recommends for use by others. Except for the mention of some unpublished experiments with diiodotyrosine in 1941, there is no indication in the text or bibliography that he has tested or intends to test the conclusions or recommendations so blandly offered. Representative examples are: hypoglycemia not caused by hyperinsulinism may be due to overactivity of the vagus nerves to the liver, and atropine, barbiturates, or section of the nerves is recommended. The use of thyroid over long periods damages the liver; however, diiodotyrosine is harmless, and is useful in reducing the blood cholesterol level. Hormone therapy should be instituted early in acute

infections in order to prevent irreparable damage to the tissue by pathogenic microorganisms.

The elements of originality, if any, are quite obscured by the method of presentation and the lack of proof, or even the suggestion of experiments by which the author's hypotheses might be tested. The contents of this book are neither profound nor provocative of the desire to test and study.

PAUL A. LEMBCKE

BASEDOW'S DISEASE.

By H. Sattler; English translation by G. W. and J. F. Marchand. Grune & Stratton, New York. $10.00. xviii + 605 pp. 1952.

THE THYROID. *A Physiological, Pathological, Clinical and Surgical Study.*

By T. Levitt. E. & S. Livingstone, Edinburgh and London; [The Williams & Wilkins Company, Baltimore.] $20.00. xxiv + 606 pp.; ill. 1954.

LECTURES ON THE THYROID.

By J. H. Means. Harvard University Press, Cambridge. $3.00. xii + 113 pp. + 2 pl.; text ill. 1954.

In a recent article on the "Opportunity for Research in General Practice" (*J. Amer. Med. Ass.*, 154: 639, 1954), W. B. Bean made the statement that "the most striking phenomenon of our contemporary age of science is this languishing of those aspects of health and disease called natural history." Personally, I am in complete accord with Dr. Bean. The gadgeteer is no substitute for the naturalist. This lack of study of the natural history of disease is due partly to the development of new tools, and partly to the fact that few patients suffering from diseases amenable to treatment stay untreated for considerable lengths of time. Thyrotoxicosis (Graves' disease) is a case in point. The result is a paucity of information about the natural history of this disease in the recent literature. Fortunately there is a wealth of information buried in the older literature. We have to be grateful to J. H. Means and E. B. Astwood for making available to us the comprehensive review published in 1908 by the eminent Austrian ophthalmologist, Hubert Sattler. This classic has been out of print for many years and is practically unknown to the younger generation of endocrinologists. Sattler's *Die Basedowische Krankheit* discusses 103 cases of Graves's disease which came under his own care and 3,800 cases reported in the literature up to 1907. The bibliography lists 3,210 articles and books with full titles; 1,932 of these were published prior to 1900, indicating the great interest in thyroid disease during the nineteenth century. This book is by no means an annotated bibliography but rather an integrated treatise on the subject, reflecting the author's deep understanding of the various aspects of thyroid disease. It is of great interest that some of the interpretations, based on keen observation and accurate measurement, stand unchallenged today, as, for instance, the work of Friedrich von Mueller (1893) and of Adolf Magnus-Levy (1896) on metabolism in Graves's disease. Mrs. G. W. Marchand and J. F. Marchand have produced an excellent translation. It is somewhat puzzling, however, at least to me, why the eponym "Basedow's disease" is retained in the title and throughout the book instead of the eponym "Graves' disease", which is almost exclusively used in English-speaking countries. Incidentally, a glance at Sattler's bibliography shows us that Graves published a description of the disease that bears his name five years before Basedow. The publishers, Grune & Stratton of New York, have produced a beautiful volume at a considerable financial sacrifice. They realized the importance of publishing a book of this kind even though it could not be a commercially rewarding venture.

It is hardly a mere coincidence that a number of the older papers on thyroid disease, originally published in German, are now being translated into English. The distinguished British surgeon, T. Levitt, has written a most interesting book on the thyroid and as an appendix has added a translation of Riedel's and Hashimoto's original articles. Levitt's book is highly individualistic, based on the author's experience in diagnosing and treating thyroid disease. The author presents a detailed study of 2,114 consecutive thyroidectomies performed by himself. It is not surprising that a surgeon who has cut out so many thyroids likes the procedure and considers it the method of choice in treating Graves' disease. "Surgery still remains the ideal treatment." The author considers diffuse-lymphoid hyperplasia (Hashimoto's struma) and fibrosis of the thyroid (Riedel's disease) as advanced phases of the toxic thyroid gland. There is considerable disagreement among pathologists about this. The book is profusely illustrated, with more than 500 illustrations, many of them in color; and the standard of illustrations is consistently high. The illustrations can well serve as an atlas of surgery and pathology of the thyroid and will be enjoyed by many readers, even if they cannot agree with the author on all points.

The Harvard University Press presents us with a collection of 5 lectures on the thyroid delivered by J. H. Means between 1949 and 1953. These lectures cover many aspects of endocrinology and, although not in any way planned as a sequential course, epitomize the author's thoughts on the subject—thoughts derived from 40 years work as head of the Thyroid Clinic of the Massachusetts General Hospital. Thus, this book of little more than 100 pages offers a coherent picture of present-day knowledge of the thyroid, as drawn by a master.

To whom can these three books be recommended? Sattler's work is of interest not only to the specialist in

thyroid disease, but also to everyone interested in the natural history of disease in general. The historian of medicine will find it a valuable guide to nineteenth century thought in the field of endocrine medicine. Levitt's book will appeal mostly to surgeons and pathologists. Means' lectures should be on the shelf of every physician and biologist.

WALTER FLEISCHMANN

PHARMACOLOGY AND TOXICOLOGY OF URANIUM COMPOUNDS. *Chronic Inhalation and Other Studies. National Nuclear Energy Series, Division VI, Vol. 1, Parts 3 and 4.*

Edited by Carl Voegtlin and Harold C. Hodge. McGraw-Hill Book Company, New York, Toronto, and London. $18.00 (2 books). Part 3, xviii + 1087–1778; ill. Part 4, vi + pp. 1779–2466; ill. Cumulative Index, 30 pp. 1953.

Parts 3 and 4 of this "volume" are bound as two separate books. (Parts 1 and 2, *QRB.*, 26: 88. 1951) Parts 3 and 4 are concerned chiefly with the chronic inhalation toxicity of uranium compounds and the mechanism of uranium poisoning. As in the case of the earlier volumes, which appeared in 1949, the present parts of this tremendous task are carefully prepared and minutely documented. In addition to providing a pattern for the evaluation of the toxicity hazards of any industrial chemical, the work has answered the important questions of the maximal allowable concentrations of soluble and insoluble uranium dusts. Presumably in an atomic age this knowledge may have far-reaching personal importance. As acknowledged by Hodge in the Preface, the completion of these studies has made possible the recommended air concentrations of uranium dusts that men may safely breathe. "Providentially, this highly toxic metal is not easily absorbed. The studies in Parts 3 and 4 present the evidence." Special mention should be made of the 30 contributing authors who collaborated in this project.

The two books are very well printed and bound. They contain innumerable tables, figures, and photographs of apparatus with details of design. The bibliography of each chapter covers several pages. Parts 3 and 4 contain a cumulative index for all four books, in addition to which each book has its own index.

It would be quite impossible to present a summary of a task of this magnitude. It is sufficient to note that the work presents the most significant collection of biological data currently available on its subject. Investigators concerned with biologic phenomena involving uranium will find here an encyclopedia of information.

C. JELLEFF CARR

STREPTOCOCCAL INFECTIONS. *Symposium Held at the New York Academy of Medicine, February 25 and 26, 1953.*

Edited by Maclyn McCarty. Columbia University Press, New York. $5.00. x + 218 pp.; ill. 1954.

The fifteen papers presented at this symposium are organized to cover the biology and chemistry of streptococci (principally group A), the cellular localization of injected streptoccal antigens, and the host factors in experimental infection. Sections on the clinical aspects, epidemiology, and prophylaxis of streptococcal infection are also included. The final section deals with the sequellae of streptococcal infection, including acute hemorrhagic glomerulonephritis and antibody response in rheumatic fever. This series of papers is not intended as a comprehensive treatment of streptococcal disease, but as a discussion of the diverse potentialities of the streptococci and the more recent developments in the study of these organisms and the host response. An extensive bibliography is included with each of the papers. The 15 authors of the papers presented are recognized authorities on streptococcal disease, and it is to be expected that this volume will be extremely useful as a reference to workers in this field, to physicians interested in infectious diseases, and to students.

PAUL F. WEHRLE

PATHOLOGY. *Second Edition.*

Edited by W. A. D. Anderson. The C. V. Mosby Company, St. Louis. $16.00. xvi + 1394 pp. + 10 pl.; text ill. 1953.

This textbook continues to provides the most satisfactory and comprehensive survey of all aspects of pathology. For the most part, the subject matter is covered as in the first edition by 33 specialists who contribute chapters on general pathological changes as well as on system and organ pathology. The book is very large, but its format is improved by utilizing double columns of type and better headings. The relative importance of the material described is emphasized by the use of large and small type.

Although only 5 years have elapsed since publication of the first edition, there have been many advances in pathological investigations. Many subjects have been rewritten to incorporate this most recent information. Such topics as allergic inflammation, coagulation of the blood, influence of therapy on tuberculosis, and tumors of the thyroid are completely new and up to date; and smaller revisions, deletions, and additions have been made in virtually every chapter. Many new references have been added to the bibliography, and illustrations are more numerous than before. In summary, this

volume represents the best pathology text and reference book available today.

ELLA H. OPPENHEIMER

GYNECOLOGICAL AND OBSTETRICAL PATHOLOGY.

By Peter A. Herbut. Lea & Febiger, Philadelphia. $12.50. 683 pp. + 2 pl.; text ill. 1953.

Here is another of Herbut's authoritative and well-written treatises on the intimate pathology connected with a medical specialty. Although written by a general pathologist, it rates equal consideration with the other books in this field all written by recognized gynecological and obstetrical pathologists. All textbooks of gynecological and obstetrical pathology, however, allot most of their pages to gynecology and only one-fifth or less to obstetrics. Herbut's is the only one that discusses any maternal pathology other than hydatid moles and chorionepitheliomata. Even Herbut gives only one page to the pathology of maternal death, and not a single page to fetal and neonatal pathology.

The weakest feature of Herbut's book is the brief space given to the pathology of the normal and abnormal menstrual cycle, especially with regard to ovarian changes. Clinicians will also be surprised to find a textbook of pathology discussing matters of treatment so thoroughly.

Purists will certainly consider the thoroughness and readability of this book marred by the author's habit of addressing them possessively as "your author." Most clinicians and pathologists, however, will welcome this excellent addition to the small group of books in a limited but important field.

GEORGE W. CORNER, JR.

MALIGNANT DISEASE AND ITS TREATMENT BY RADIUM. *Volume IV. Second Edition.*

By Stanford Cade; foreword by Ernest Rock Carling. Williams & Wilkins Company, Baltimore. $12.50. xv + 544 pp.; ill. 1952.

This is the fourth and last volume of a carefully compiled, 4-volume series dealing with the clinical and radiological aspects of malignancy. As one might suspect from the title, this work predominantly deals with a single phase of the therapy of malignancy. Throughout this comprehensive work, the author draws upon wide surgical experience to give an honest objective basis to the handling of malignant disease. Each clinical stage of any particular malignancy is carefully considered in an attempt to present the best methods of treatment; that is, whether it should be surgery, irradiation, or a combination of both. The work is well illustrated throughout, and Cade's opinions as to therapy are well based on an extensive statistical analysis.

This fourth volume is divided into 7 chapters dealing with malignant disease of the skin, kidneys, testes, and prostate, and with bone sarcoma, sarcoma of soft tissue, tumors of lymphoid tissue, the leukemias, and intercranial tumors. Although many American authorities may disagree with the author as to his choice of therapy, there can be no disagreement with his results. He goes into great detail in describing his methods of therapy, and the clinician will find this volume of great use for many years to come. Each disease is described as to its natural history, gross and microscopic pathology, clinical stages, prognosis, and best method of treatment. But it is in the field of radium therapy that Cade presents a necessary mass of minute detail in such a manner that the clinician and those interested in the basic sciences can understand and derive as much benefit from it as the radiotherapist. This volume, as well as the other three, is well illustrated in both black and white and color.

ROBERT G. CHAMBERS

SYLLABUS OF HUMAN NEOPLASMS.

By R. M. Mulligan. Lea & Febiger, Philadelphia. $7.50. 317 pp.; ill. 1951.

This syllabus is, as its size indicates, short and concise in comparison with the great range of material it includes. It is of value as a supplement to larger texts for medical students and is an excellent reference for the busy hospital house officer and practicing physician and surgeon. The text is necessarily brief in a volume of this size, but each subject is sufficiently described to give adequate information for diagnosis. Reference to the clinical symptoms and prognosis is given to round out the discussion of each tumor. Interesting rare tumors and tumors in animals related to human neoplasms are mentioned.

In the arrangement of the 11 chapters, emphasis has been placed on the cell (or cells) of origin of the neoplasm under consideration, as related to its histologic and embryologic derivation. The order of subject matter is excellent.

There are 230 photomicrographs, most of which were made from tissues obtained at operation on patients in the Colorado General Hospital. All are excellent black and white reproductions.

Simplicity in the presentation of subject matter and a logical classification have been accomplished. A help to the medical student and to younger practitioners is the brief outline of the derivation of many terms.

GRANT E. WARD

CANCER. *New Approaches, New Hope.*

By Boris Sokoloff. The Devin-Adair Company, New York. $3.75. 243 pp. 1952.

This is an excellent, readable little book explaining the cancer problem in the light of our present-day knowledge. It is valuable for doctors (the general practitioner, general surgeon, and others) who need a summary of the available information about cancer and who haven't time to read or access to larger treatises, on the subject. The clear, simple language will enable laymen to obtain a general picture of the most important advances in the prevention and treatment of malignant diseases.

The first chapter, About Cancer Research and Treatment, explains the purposes and directions of past and present research and describes the various types of accepted treatments. Among other subjects of vital interest which are outlined are the question of the contagion of cancer, chemically induced cancer, and the relation of hormones, nutrition, and metabolism to the development and treatment of cancer. The story of bacterial toxins in cancer treatment is told in a plain, understandable manner. Various other problems are discussed. A large bibliography, with notes by the author, will help anyone interested in studying in greater detail any of the phases of the cancer mystery.

This book is one every medical student should read, as it clarifies and condenses the available knowledge of cancer and gives insight into fields for further research. It is stimulating and thought-provoking.

GRANT E. WARD

1953 MEDICAL PROGRESS. *A Review of Medical Advances During 1952.*

Edited by Morris Fishbein. The Blakiston Company, New York and Toronto. $5.00. xii + 302 pp. 1953.

1954 MEDICAL PROGRESS. *A Review of Medical Advances During 1953.*

Edited by Morris Fishbein. The Blakiston Company, New York and Toronto. $5.00. x + 346 pp. 1954.

These volumes should be of interest not only to the general practitioner, but to medical educators who desire to follow current medical progress by a series of essays written by competent authorities in each of the fields covered. In these volumes the progress made for the past decade has been adequately reviewed, and it is the editor's hope to bring out regularly volumes of this kind containing articles by recognized authorities. In these two volumes the articles range from cardiology and surgery to psychiatry and psychosomatic medicine. Both volumes have a brief chapter by the editor, Summary Notes on Medical Advances. These treat lightly, but not critically, current claims in certain medical specialties.

DAVID B. TYLER

PSYCHOLOGY AND ANIMAL BEHAVIOR

MEDICAL PSYCHOLOGY.

By Paul Schilder; Translator and Editor, David Rapaport. International Universities Press, New York. $7.50. 428 pp.; ill. 1953.

The psychiatric and psychologic worlds should be deeply indebted to David Rapaport for his translation and editing of this volume of Schilder's *Medizinische Psychologie*. Besides presenting a very readable translation of a rather extraordinary book, the translator has also done a remarkable job in providing a bibliography covering all the material in the text, also in adding footnotes concerning Schilder's point of view and comparing it with more recent points of view in many areas, and in adding material especially from his own researches. In an appendix is his own Schilder Memorial Address, given to the Schilder Society in 1951, on Paul Schilder's Contribution to the Theory of Thought Processes.

It would be difficult to classify this book. There is nothing like it in English so far as I know. In fact, there was no one quite like Schilder. Where else one can find in English a presentation of material from experimental psychology, clinical psychiatry, psychoanalysis, clinical neurology and neuropathology, and philosophy, I would not know. I believe there is no other such book to be found.

The book is divided into an Introduction, followed by chapters on The Theory of Perception; Action and Language; Memory; Drives, Will, and Action; and Ego and Personality. The material covered in these chapters is of the most diverse sort and, as with much of Schilder's work, one has the impression that the author leaps from idea to idea, weaving an intricate web of connecting associations without finally spelling out a completed theory, but leaving this for others to do. Unfortunately, most of these finely spun webs have remained such since his untimely death, and the problems envisaged at that time also remain today, in large measure, where they were then. In this volume one will find topic after topic that is scarcely mentioned in modern textbooks of medical psychology or psychiatry. In the present-day absorption in psychoanalysis of the inner workings of the mind, that broad effort to correlate this material with material from other disciplines, such as Schilder shows in this book, is simply not to be found; and I imagine it is not found because there is no one capable of doing it. It would be only displaying one's own interests to pick out special topics, but the material on visual, acoustic, and tactile perceptions, and on action, speech, and memory is extraordinarily interesting. In regard to memory, here is Schilder's insistence that no sensory impressions are ever lost—a theory difficult to prove or to deny, but, in its very failure, Schilder marshalls a very considerable array of material. This is one example of the kind of provocative statement found throughout the book and offering a

working hypothesis, whether true or not. This book, now a number of years old, will repay the earnest scrutiny of present-day workers, who will find between its covers an abundance of challenging problems needing further elucidation today as badly as they did when the book was first written.

WENDELL MUNCIE

FUNDAMENTAL CONCEPTS IN CLINICAL PSYCHOLOGY. *By G. Wilson Shaffer and Richard S. Lazarus. McGraw-Hill Book Company, New York, Toronto, and London.* $6.00. xi + 540 pp.; ill. 1952.

In this text book are represented all of the major areas with which clinical psychologists have been concerned. The course of test development from the work of Binet to modern projective techniques is described, with a brief history of abnormal psychology. There are critical chapters on the measurement of intelligence, personality, and aptitudes. One-fourth of the book is devoted to psychotherapy.

The emphasis of the authors is on a scrutiny of the principles and assumptions which are implicit in the current practices of clinical psychology. Inasmuch as these practices are evaluated with reference to the experimental work available, the book also serves as an excellent review of a great deal of varied psychological research.

MYRTLE ASTRACHAN

OUR COMMON NEUROSIS. *Notes on a Group Experiment.*

By Charles B. Thompson and Alfreda P. Sill. Exposition Press, New York. $3.50. xxxii + 210 pp. 1952.

With this book the authors have given a handsome present to many who are, as spectators or participants, interested in problems of mental hygiene. For the illustration of many points they can easily draw upon the 53 sketches and essays; and the running commentary by the authors will provide them with worthwhile information on the need for a Science of Human Behavior; on Group Analysis; on Emotional Bias; on Social Conditioning; the Social Image and the "J-Persona"; on Man as a Unitary Organism and on Personal Patterns; and on Man's Behavior. In some of these headings the experienced reader will recognize the terminology of Trigant Burrow. Indeed, it was he who about thirty years ago acted as godfather to a then rather audacious undertaking of Dr. Charles B. Thompson, who at this time was Medical Director of the Mental Hygiene Society of Maryland.

This book is a belated child of that early endeavor, when a group of lay individuals edited with Dr. Thompson the journal *Mental Health*, and the sketches in this book are reprinted from their original contributions to *Mental Health* (1923–1926). This cooperative enterprise was part of an experimental and experiential group living, inaugurated and shared by Dr. Burrow. It is his kind of social analysis and of psychiatry, or phylobiology, which the authors present in reflective commentaries binding together the socio-dramatic sketches.

In a Foreword, Trigant Burrow outlines some major steps in the development of his work and his fundamental concepts. He died before this book was completed, but it may be hoped that some of his readers will turn to Dr. Burrow's important writings on the social nature of behavior disorders, especially to his last publication—*The Neurosis of Man—An Introduction to a Science of Human Behavior.*

WALTER O. JAHRREISS

THE PHILOSOPHY OF PSYCHIATRY. *Psychiatric Prolegomena.*

By Harold Palmer. Philosophical Library, New York. $2.75. ix + 70 pp. 1952.

This small book should be read by every psychiatrist, whether beginner or master. The material is well chosen and excellently organized. Its precise formulation and the complete lack of any cryptic or esoteric jargon testify to the author's ability to think clearly and to clarify the reader's own thinking.

To review the content of this work would almost mean to repeat it verbatim. A few quotations, however, might convey some of the author's concerns and opinions:

"... because of the psychiatrist's habitual lack of training in philosophy, there results much confusion of categories. Psychiatrists (unwittingly) evade these issues by seeking refuge in loyalty to one or other of the various "schools of thought" (until their maturation results either in the creation of a new school of the "neo" variety, or esotericism). ...

"Psychiatrists should receive a training in philosophy so that the intended meaning of terms used by them shall be stipulated, and the esotericism and the ambiguities of syntax so characteristic of their specialty shall be reduced to a minimum. Only by so doing can the discussions of psychiatrists become communicable and discussable. Of fundamental importance in all such discussions is a stipulative definition of the 'soul' and human 'purpose'. ...

"The clinical psychiatrist is, however, not primarily concerned with the rules of logic or the science of constructing propositions, but rather with establishing a means of communication with his patients who are members of the laity. His secondary concern is to establish a framework of reference which may be related to those other disciplines of study, such as anatomy, physiology, psychology, and sociology with which he comes into contact. These prolegomena have been designed especially for this latter purpose. ...

"For it is considered that a study of purpose (or the study of human souls) belongs by right to any who in sincerity feel they have a contribution to bring. The

physician, however, has been vested by modern western society with certain privileges in the matter of therapy. These privileges are of necessity accompanied by responsibilities so that he is accountable at law for his acts. There are sound reasons therefore for scrutinising the claims of any whose therapy in the matter of human purpose is not accompanied by a responsibility and an accountability at law comparable to those of the physician. For these reasons the only really solid standpoint of psychiatry lies within the medical specialty, because therein the physician is invested by society with the responsibility of judging whether and when a person is sick or healthy and what are sound remedies and is himself responsible to society for the quality of his acts."

WALTER O. JAHRREISS

THE CASE OF DORA AND OTHER PAPERS, *by Sigmund Freud.*

Translations by Joan Riviere, Alix and James Strachey, R. C. McWatters, E. B. M. Herford, and E. Colburn Mayne. W. W. Norton & Company, New York. $3.50. vi + 243 pp. 1952.

This reprint of classic papers contains the following: One of the Difficulties of Psychoanalysis (1917); Dora: an Analysis of a Case of Hysteria (1905); Obsessive Acts and Religious Practices (1907); The Sexual Enlightenment of Children (1907); "Civilized" Sexual Mortality and Modern Nervousness (1908); Contributions to the Psychology of Love: A Special Type of Choice of Object Made by Men (1910); Ibid.: The Most Prevalent Form of Degradation in Erotic Life (1912); Ibid.: The Taboo of Virginity (1918).

20 YEARS OF PSYCHOANALYSIS. *A Symposium in Celebration of the Twentieth Anniversary of the Chicago Institute for Psychoanalysis.*

Edited by Franz Alexander and Helen Ross. W. W. Norton & Company, New York. $3.75. 310 pp. 1953.

This symposium, with 20 contributors, is in celebration of the first twenty years of the Chicago Institute of Psychoanalysis. Alexander, the founder of the Institute, discusses his own development of the goals which he has pursued as head of the Institute. Alan Gregg gives a very thoughtful presentation of the contribution of psychoanalysis to medicine by posing the question: Is medicine influencing human thought as deeply as it might? Maurice Levine discusses the impact of psychoanalysis on training in psychiatry; Martin Grotjahn, present trends in psychoanalytic training; Lawrence Kubie, psychoanalysis as a basic science; I. Arthur Mirsky, psychoanalysis and the biological sciences; and Talcott Parsons, psychoanalysis and social science. These contributions are all broad, well-reasoned, and pose fundamental questions. The second part of the volume has to do with specific training methods and research problems at the Institute. In this part of the book, there is spelled out the innovations in treatment procedures, initiated by the Chicago group, Adelaide Johnson making the presentation. She makes a good case for the general plan of treatment procedure. As with all symposia on such occasions, there is a heavy larding of tributes, not unearned, I am sure, and in keeping with the spirit of the occasion. It is a thoughtful, well worthwhile book, and will repay careful reading.

WENDELL MUNCIE

THE REVIVAL OF INTEREST IN THE DREAM. *A Critical Study of Post-Freudian Psychoanalytic Contributions, with an Article on the "Spoken Word."*

By Robert Fliess. International Universities Press, New York. $3.00. 164 pp. 1953.

This small volume contains a sell-organized collection of the author's reviews of psychoanalytical contributions to dream theory by various writers. The author's hope and purpose is to cut for the student a path through the literature overgrowing Freud's Interpretation of Dreams, to acquaint him with some new ideas, and thus to renew the interest in this field. The reviews are concise and critical, and the author takes great care to document his own differing opinions. This documentation is, in a somewhat judicial manner, given in the form of references to or abstracts from writings by Freud, though the author is aware that the theory of the dream is not only incomplete—as Freud believed—but that it contains a number of errors.

The concluding part of the volume is devoted to a careful investigation of the problem of the "Spoken Word in the Dream." This study was prompted by a remark of Otto Isakower, that "since the nucleus of the super-ego is auditory—words in a dream may be a contribution of the superego to the dream."

The author comes to the conclusion that the production of direct speech is a *third* instance of temporary reestablishment of the superego in dreams, in addition to the two described previously by Freud as "a reaction against the dream," and as "occurring particularly in response to the stimulation [of the superego] by the unconscious wish-fulfillment." Direct speech "occurs in response to a threat of the ego organization of the dreamer in the course of the wish-fulfillment." Yet, according to the author—and in correction of the suggestion by Isakower—it is not the superego alone which contributes direct speech to the dream. "The spoken word is produced jointly by ego and superego, irrespective of motor or sensory qualities in a dream."

It remains obvious that the author's conclusion rests on the basic assumptions of Freud's dream theory;

and that the "correctness" of this conclusion depends on the acceptance of that theory.

WALTER O. JAHRREISS

AFFECTIVE DISORDERS. *Psychoanalytic Contribution to Their Study.*

Edited by Phyllis Greenacre. International Universities Press, New York. $3.00. 212 pp. 1953.

From panel discussions, held at meetings of the American Psychoanalytical Association in 1950 and 1951, the editor of this symposium selected 5 papers: The Mechanism of Depression (Edward Bibring); Contribution to the Metapsychology of Cyclothymic Depression (Edith Jacobson); The Depressive Position (Elizabeth Rosenberg Zetzel); An Equivalent of Depression: Anorexia (George Gero); and Mania and the Pleasure Principle (Maurits Katan). Each of these authors is known for his interest and special experience in the field of affective disorders. As some of the main problems are discussed by more than one of them, though from different points of view, it is only to be expected that the reader will meet a variety of opinions and differing conclusions. The small volume certainly lives up to the editor's intention, namely, to stimulate thinking about depression and, perhaps, to suggest ways for further studies rather than to cover its whole field systematically. This reviewer agrees with Phyllis Greenacre's closing remarks in her Foreword: "It is . . . a heartening indication of growth of analytic vision that it again concerns itself with psychoses and borderline stages. . . ."

It would be strange, indeed, if this concern, this attempt to come to grips with the psychotic person, should not advance the rapprochement between psychoanalysis and psychiatry. The following considerations in some of the contributions to this symposium are noteworthy and perhaps significant in this regard: the attempt to differentiate between normal, neurotic, and psychotic depression, or between simple and cyclothymic depression; the emphasis on making a "correct diagnosis," since "from the therapeutic point of view [this] will guide our choice of methods for treatment"; the occasional mentioning of "psychosomatic" or "endogenous features," or "processes," in the cyclothymic depression; or of "constitutional factors"; the recognition of many mild depressions as nevertheless being "psychotic"; or the interest in the psychopathological description of clinical syndromes, and so on.

It seems to me that the psychoanalytical, historical-genetic, and dynamic interpretation of "psychotic" reactions would profit if some of the terminology were to be revised, e.g., the somewhat glib use of the words "aggression" and "aggressive." The manic overactivity, irritability, etc., are not what they seem to be, namely, manifestations of aggressiveness, if one recognizes the necessity to understand the patient's actions as behavior in and reaction to the psychotic world in which he finds himself. For him the "physiognomy" of the world has changed, and with it the experience of space and time and the value and meaning of objects and people in this world. At any rate, I do not think it justified to equate *apparent* aggressiveness in manics with *actual* aggressiveness; nor does it seem quite possible to arrive on the basis of such equations at valid and meaningful conclusions as to supposed psychodynamic mechanisms.

WALTER O. JAHRREISS

THE HAND IN PSYCHOLOGICAL DIAGNOSIS.

By Charlotte Wolff. Philosophical Library, New York. $7.50. xv + 218 pp. + 24 pl. 1952.

This volume is concerned with "the study of the hand in relation to psychological diagnosis, as a new branch of psychology—a pioneer study, still in the process of development," and it represents a continuation, extension, and revision of much former work in this field by the author.

The book will interest those who share the author's acknowledged "bias" and who are convinced or "feel" that constitutional factors play a role, perhaps even a decisive one, in the psychological development of the individual person; and who for this reason are neither irritated nor alarmed to hear about the importance of endocrine factors for a person's total physique or for one of its significant parts, as well as for his emotional and intellectual equipment and performance. For readers of this kind there exists an almost self-evident correlation between some "typical" body configuration and some emotional "type," expressing itself in more or less predictable motor behavior, intellectual potentialities, and particular attitudes towards other people and towards life in general. Those, however, who can neither "see" such correlations between the "characteristics of the hand and characteristics of the emotional make up," nor accept constitutional factors of temperament as the hypothetical substratum and pacemaker for such correlations, will dismiss the subject of hand-interpretation as some sort of charlatanism. Even the author's serious, extensive, devoted study is not likely to succeed where, according to the author's own statement, Sir Charles Bell failed 100 years ago.

Yet, there is something intriguing about the so-called constitutional approach to psychology or psychiatry. It seems to grant a glimpse at the very famous but equally elusive "total person in function." Unfortunately, this approach is soon caught in a more or less elaborate net of "types." They are abstractions, not realities, but they lend themselves all too easily to diagnostic and prognostic shortcuts. They have their

value as directional hints for diagnostic and prognostic thinking, but are no substitute for actual knowledge.

WALTER O. JAHRREISS

PERSONALITY DEVELOPMENT.

By J. S. Slotkin. Harper and Brothers, New York. $4.50 x + 401 pp.; ill. 1952.

Written by a social anthropologist, this book aims at a full account of personality development based on relevant findings from the relevant disciplines. To ensure thorough coverage, it is divided into four parts: Inheritance, Socialization, Culturization, and Individualization. The author's particular aim is to show how social role and status properties, together with cultural patterns, produce the basic personality of the child by the time it is five years old. In attempting to show this he draws on a wide variety of sources, with strong emphasis on child development observations in other cultures.

If the net result of this ambitious program is somewhat disappointing as "a systematic theory of personality development," it is just because the author has apparently regarded such vital feelings as love, hate, and anxiety, together with other feelings as being unimportant for an understanding of early personality functioning and formation. Love is referred to but once in the entire book, and then as follows: "Love is altruistic affection. Evidently once the child has become intimate and altruistic with someone he likes, his affection takes the form of love." Nor do defense mechanisms fare much better; these are treated in a wordy fashion, and almost as an addendum to the rest of the book.

Although the idea of writing a book on personality development from the social anthropologist's viewpoint is an excellent one, one wonders how useful this book will be to the student. It is a hastily written book with many turgid paragraphs like the following: "Sympathy seems to arise, not out of either social projection or introjection alone, but rather from a special combination of both which may be called subjunction. As far as I can see, the child first engages in social introjection (empathy, incorporation, or both), and then projects (ejects) the introjected experiences and responds to them sympathetically as the inferred experiences of another rather than his own." The book abounds in distinctions like the foregoing, many of which seem quite gratuitous in so far as their value for understanding or theory seems concerned. Thus, four kinds of "self" are defined, presumably to correspond to the fourfold division of the book; there are, in any one personality makeup, a "biological self," a "cultural self," a "particular self," and a "social self." This proliferation of novel terms and definitions is equalled only by the author's fondness for lengthy quotations, footnotes, and historical notes. One is left with an impression of this book as a polemic for social and cultural determinism that seeks to force its readers into submission with a barrage of definitions, jargon, quotations, and footnotes. Just how far the author can distort the obvious in his zealous enterprise may be judged from the following: "I find it hard to differentiate between neuroses and psychoses. Even within our own culture the conventional distinctions strike me as glib rather than fitting the facts. The problem is further complicated when we try to make distinctions which will be valid for all cultures. It is my hypothesis that neuroses and psychoses do not differ in the defense mechanisms employed, but rather in the social and cultural implications of these defenses. I would suggest that in a *neurosis* the individual's defense mechanisms allow him to conform, by and large, to the customary perceptions of situations found in his group, although these mechanisms require so much effort to adjust to the conflict that he cannot adjust adequately to other situations. In a *psychosis* the individual's defense mechanisms lead him to perceive situations in individually developed ways which are in marked nonconformity with those customary in his group."

This is the kind of a book that is almost like a transcript of the writer's lecture notes and quotations. Under the circumstances it is likely to be of greatest value to students in the writer's own course.

ERLING W. ENG

PERSONALITY MEASUREMENT.

By Leonard W. Ferguson. McGraw-Hill Book Company, New York, Toronto, and London. $6.00. xv + 457 pp.; ill. 1952.

At a time when basic questions of personality measurement tend to be buried under a proliferation of measuring devices, this is a welcome book. The author has aimed to produce a handbook for all who are interested in the different basic approaches to the measurement of human interests, attitudes, personality variables, adjustment, and work performance. Following an introductory section on fundamental concepts, 14 different approaches to personality measurement are discussed in as many chapters. Each approach is first illustrated by means of one or more tests or techniques that have proved to be of practical value. After each illustration, questions of reliability, validity, and rationale, together with problems of interpretation, are considered. The 14 various basic approaches are defined by the author as follows: empirical and rational, a priori and a posteriori, uni- and multidimensional, diagnostic and prognostic, analytical and non-analytical, perceptual and imaginal, observational and experimental. The author's view is that virtually all devices for measuring personality can be constructed on the basis of the principles underlying these 14 ap-

proaches. By virtue of examples of personality measurement from many different contexts, clear thinking, lucid language, and succinct organization, this is an eminently usable, practical handbook. It should prove of value to students in all the behavioral sciences.

ERLING W. ENG

EARLY PHASES OF PERSONALITY DEVELOPMENT: *A Non-Normative Study of Infant Behavior. Monogr. Soc. Res. Child Developm., Vol. 17 (Serial No. 54), No. 1, 1952.*

By Sibylle Escalona, Mary Leitch, and others. Child Development Publications, New Orleans. $1.00 (paper). vi + 72 pp. 1953.

This is a description of a research project on infant behavior carried out at the Menninger Foundation between 1944 and 1951, when the data-collecting phase of the project was completed. None of the data or findings are presented in this introductory monograph; these have been or will be reported in separate papers on special topics.

The team consisted of workers in psychiatry and psychology interested in a thorough behavioral study of infant development. The aims of the study were: (1) to describe the range and variability of normal infant behavior during the first 7 months of life; (2) to explore the relationships between formal findings on psychological tests and the infant's pattern of behavior in everyday life; (3) to explore the relationship between specific environmental factors and modes of infant behavior; (4) to determine the relationship between different facets of behavior displayed by the same child; (5) to study the determinants of maternal attitudes, including such factors as sources of authority, mother's personality structure, presence or absense of a stable value system within the mother, social and cultural forces, etc.; (6) to establish whether there exists a relationship between (probably) organismic characteristics of infants and maternal practices (for example, do mothers of active and robust infants choose child-rearing methods characteristically different from those chosen by the mothers of sensitive, physically fragile infants?); and (7) to explore the relationship between perceptual sensitivities and the development of early ego functions.

The final group of subjects numbered 128 infants, with 16 (8 boys and 8 girls) at each monthly age level, beginning at 4 weeks and continuing through 32 weeks of age. An extra-ordinarily wide variety of data was gathered on each child and its mother for later analysis under the guidance of specific hypotheses. Members of the research group expect their treasury of multivariable data on small infants and their mothers to be of value to many other persons with hypotheses about infant development. The great care and knowledge that has gone into the planning of this project makes this hopea realistic one. Nevertheless, it seems that most new personality and behavior research groups continue to have the need to derive their own data with their own improved methods and concepts for the testing of those hypotheses most significant to them.

ERLING W. ENG

THE PSYCHOLOGY OF PERSONALITY.

By Bernard Notcutt. Philosophical Library, New York. $4.75. vi + 259 pp. 1953.

Notcutt is widely and well-informed and writes easily with a pleasant sense of humor. The present book, while offering much of interest for introductory students, seems a bit more suitable for the curious general reader who wants to find out something about the psychology taught by psychologists.

After several introductory chapters that deal with the basic concepts used in thinking about personality, attention is turned to methods for the systematic assessment of personality. Historical contributions from Gestalt, psychoanalytic, and behavioristic strains are introduced wherever relevant, and deftly, succinctly appraised. The author's predilections are for concepts derived from direct contacts with people in "natural" situations and for an intensive study of the individual life history. With these preferences, it is not surprising that he regards the contributions of Freud and his successors as having the greatest promise for the future development of personality theory. In taking this position, however, he does not fail to appreciate the provocative contributions from other directions, nor the methodological requirements that must be met by a more stringently scientific psychoanalysis. In this regard he says: "Private symbolism is responsible for a considerable part of the variations in human nature, which account for the lack of psychological laws. If we consider the structure of private symbolic systems to be outside the legitimate scope of science, we are condemning scientific psychology to another twenty years of missing the point." A special chapter on the development of the notion of personality from the thought of the classical Greeks down to the present day concludes the book. In the current flood of technical publications and textbooks over the entire field of psychology, it is a pleasant surprise to encounter this more relaxed, more conversational book about whither all seems tending in the systematic study of persons.

ERLING W. ENG

INTRODUCTION TO THE RORSCHACH TECHNIQUE. *Manual of Administration and Scoring.*

By Robert M. Allen. International Universities Press, New York. $3.00 (paper). 126 pp.; ill. 1953.

This brief manual is designed as a teaching aid for a one-semester introductory course in Rorschach technique. The manual is limited to procedures for giving and scoring the Rorschach test and does not include any material on Rorschach interpretation. The author relies primarily on the procedures of Klopfer. The small size of the manual may be a convenience to students. The material, however, is largely a repetition of what is available in several standard texts on the Rorschach test.

MYRTLE ASTRACHAN

PSYCHOLOGIE DU PREMIER AGE. *Deuxieme Section: Psychologie de l'Enfant.*

By Marcel Bergeron. Presses Universitaires de France, Paris. 140 fr. (paper). 144 pp. 1951.

This volume presents a brief review of child psychology. It is one of a series (Paidela, Bibliothèque, Pratique de Psychologie et de Psychopathologie de l'Enfant) under the editorship of G. Heuyer. The book is a well-written practical guide "for physicians, judges, educators, social workers," and other students of human behavior. It describes the development of the child from birth to 3 years of age. The first part is concerned with the growth of the nervous system, and the neuro-psychological functions (motor, sensory-motor, perceptual processes, emotions, and language). The second part discusses the contributions of Piaget, Gesell, H. Wallon, and various psychoanalysts (A. Freud and R. Spitz). The third section presents a summary statement of the psychological and neurological tests applicable to young children, and concludes with neurological, social, and psycho-pedagogical principles.

The book is recommended to anyone who is interested in reviewing the contributions made by French psychologists and psychiatrists concerning early childhood.

J. H. CONN

THE ACQUISITION OF WORD MEANINGS: A DEVELOPMENTAL STUDY. *Monogr. Soc. Res. Child Developm., Vol. 15, Ser. No. 51, No. 1, 1950.*

By Heinz Werner and Edith Kaplan. Child Development Publications, Evanston. $1.75 (paper). viii + 120 pp., ill. 1952.

This is an extremely careful experimental study of the ways in which children learn the meanings of new words solely from their occurrence in a variety of printed contexts. The subjects were 125 children (60 boys and 65 girls) between the ages of 8 yrs. 6 mos. and 13 yrs. 5 mos., with 25 children in each of 5 successive age groups. A "Word-Context Test" was devised to secure data on the ways in which the acquisition of word meanings changes with age. The test was made up of 12 series of 6 sentences each. In each series of 6 sentences the same artificial word was used in different word and meaning contexts. Each of the 12 artificial words was said to stand for an object or an action. After reading each sentence the child was instructed to guess the meaning of the word in an effort to discover the single meaning that would fit all of the sentences in one series. The child was instructed to give not only his guess about the meaning, but also whatever else he was thinking.

The analysis of the data obtained by this procedure was carried out with utmost sensitivity to the different methods used by the subjects in arriving at their final answers. Consequently the study is not only valuable for its methodological contribution, but also for the light it throws on a variety of developmental changes in the characteristics of symbolic processes.

Increases in the following variables were found to be positively associated with increased age: number of correct scores; conventionality of word usage together with range of synonymity; stability, closure, and relative independence of single word meaning; stability of sentence meaning; separation of word meaning from meaning of the sentence in which it occurs; comprehension of a sentence as a definite and closed structure; use of abstract symbolism, flexible reasoning, and autocriticism in judging the adequacy of one's solutions. A noteworthy finding in agreement with several previous studies is that of a decisive change in the organization of symbolic processes around 10 to 11 years of age. At this time there is a sharp decrease in the use of more elementary processes and an increased use of abstract symbols and critical thinking.

In their discussion of the findings, the authors state that some of the abrupt changes in language processes point to saltatory features in development in contrast to the older, straight-line notion of development. They also take care to point out that the level of symbolic functioning shows considerable variability in the same person under different task conditions. For them the important question is: what is the most advanced, stable level of symbolic activity available to a person under conditions that call for an advanced level of functioning?

This study is unusual for the stimulus it gives to objective study of elusive but important psychological processes. The study of ego functions in psychoanalytic psychology may be able to profit from the use of experiments and findings like those in the present study. Of even greater value for adding power to our theory of personality structure and functioning would be the demonstration of relationships between kinds of word-meaning acquisition and factors like anxiety, impulse control, special defenses, and various modes of perceptual selection studied by Klein at the Menninger Clinic. The working out of such relationships between language behavior and other personality functions

could contribute to the formation of a unified model of personality structure. An example of one such interesting correlation is that between incidence of self-criticism and the use of more abstract symbolization. Of this correlation the authors remark: "Psychological reasons for an intimate connection between the development of ego-task relationships and stages of symbolic behavior are quite obvious: primitive forms of symbolic behavior are as much concrete as they are egocentric. The test sentences, maturely conceived, are viewed as ideal, timeless events, whereas, at the concretely symbolic level, they are dealt with as actual happenings, localized within the life space of the child. Autocriticism, likewise, presupposes freedom from egocentric involvement. Only when the distance between ego and task has become sufficiently wide can one critically evaluate one's own achievement."

At the present time there seems to be a growing interest in the use of language for research in personality functioning. This study of Werner and Kaplan should lend impetus to the trend.

ERLING W. ENG

HUMAN BEHAVIOR. *Psychology as a Bio-Social Science. By Lawrence E. Cole. World Book Company, Yonkers-on-Hudson.* $5.50. xii + 884 pp.; ill. 1953.

Prominent among the catchwords of current curriculum discussion is "integration." This word reflects the conviction that the traditional boundaries between fields of study impose artificial restrictions upon the student's fundamental understanding of man and the world. The establishment of some division of labor may be necessary as soon as a faculty expands beyond one man, but scholarly specialism has led to more fractionation in the teaching process than is necessary or defensible. To reverse this unhappy trend, several devices have been suggested. The most radical and therefore the most resisted is to develop at the elementary level courses that cut through existing departmental organization, taught either by a faculty with more general allegiance and more general training than is usual or by specialists willing to join temporarily in a cooperative enterprise. Another proposal postpones the weaving together of intellectual threads until the separate strands have been spun—the upper-class course that helps the student see the interrelations among the disparate disciplines after he has acquired a reasonable degree of basic acquaintance of them by way of the existing introductory courses. A third procedure is certainly not new, but has tended gradually to be eclipsed as the representative university teacher has become an individual of narrower competence and interests. It involves no new curriculum and no new course, but only a modified perspective within the old. In short, the instructor is to enlarge the student's view by considering material from any field that may deepen the insight into the special subject-matter of his course or that may itself be illuminated in turn by reference to the observations and principles of his discipline.

The primary objection to this last method is that too few teachers possess sufficient breadth to put it into effective practice, and that the available teaching aids are seldom adequate to remedy this deficiency. General psychology textbooks, for example, follow a conventional mold that excludes virtually all data not obtained by the methodology of psychology and immediately contiguous sciences.

The writing of *Human Behavior*, therefore, is an important event, for it comes closer to the cross-disciplinary ideal than does any of the widely used introductory text books in psychology. Cole's effort is unmistakably psychology—at least in topical organization, in basic concepts, in the primary data. But its argument is continually reinforced by allusions and extended quotations from sociology, anthropology, psychiatry and psycho-analysis (nearly 150 pages are devoted to a detailed description and critical evaluation of Freudian theory), philosophy, and general literature. No thoughtful reader could isolate the theme of this scholarly book from the rest of his experience, or conclude that psychology is a laboratory exercise relevant only to issues remote from real life. And the instructor who is concerned about arbitrary compartmentalization in higher education will find substantive help as well as moral support as he tries to confront the problem in his own course, whether it is listed as psychology or is classified among the social studies or humanities.

At the same time, however, many instructors—particularly those traditionally oriented—will hesitate to assign this book to beginning psychology classes. Psychology does not, according to the academician, consist of everything ever written about behavior. It is a body of observations and theoretical propositions based, ideally, at least, on certain limiting definitions and assumptions. While other statements about behavior may perhaps be transposable into this framework, the translation is not automatically made by the uninitiated. Hence the rules of the game in effect shift unannounced and sometimes unrecognized, and confusion rather than clarification may result from the juxtaposition of behavioral commentaries from such varied sources. Somewhat disquieting is the feeling that Cole himself is not always clear (especially in the last long section on the "self-system") how much is assimilable into objective psychology and on what terms.

From one standpoint, then, this will be judged too difficult a basic textbook for run-of-the-mine beginners. There is danger that they would at some points fail to distinguish between that which *sounds* like psychology and that which *is* psychology in the strict sense, between observations that are legitimate in behavior science only as sources of hypotheses and those that are acceptable as confirmatory data, between the

highly literate and provocative and the unfortunately subjective and esoteric, between questions that can be attacked by educated ingenuity and improved techniques and those that cannot be brought within the confines of science as we conceive it. On the other hand, the solidly grounded advanced student will be intrigued by some of these very difficulties, and the instructor will welcome them as starting points for challenging class discussion. Undoubtedly some teachers will feel that their particular students can, with guidance, take advantage of the broad sweep of content offered, without developing a distorted view of the field. Perhaps a greater number will prefer to use the book to widen their own vistas, with the achievement of "integration" dependent primarily upon the teacher-student rather than the author-student contact.

FRANK W. FINGER

RATTENBIOLOGIE UND RATTENBEKÄMPFUNG, *einschliesslich der Toxikologie gebräuchlicher Rattengifte.*

By Fritz Steiniger. Ferdinand Enke Verlag, Stuttgart. DM 11.-(paper). vii + 149 pp.; ill. 1952.

This small book contains much useful information for students of behavior as well as for agents concerned with the practical problems of rat control. A long chapter on the biology of wild rats—Norways and Alexandrines—will be of special use to students interested in the behavior of wild animals. A full account is given of present methods of rat control, with special emphasis on the use of poisons. Group organization for rat control is also discussed.

CURT P. RICHTER

MATING BEHAVIOR WITHIN THE GENUS DROSOPHILA (DIPTERA). *Bull. Amer. Mus. nat. Hist., Vol. 99, Art. 7.*

By Herman T. Spieth. American Museum of Natural History, New York. $1.00 (paper). Pp. 399–474; ill. 1952.

SOCIAL FEEDING BEHAVIOR OF BIRDS. *Fieldiana: Zool., Vol. 36, No. 1.*

By Austin L. Rand. Chicago Natural History Museum, Chicago. $1.00 (paper). 72 pp.; ill. 1954.

THE CONTRIBUTION OF MEDICINE TO OUR IDEA OF THE MIND. *The Rede Lecture for 1952.*

By Sir Russell Brain. Cambridge University Press, New York. 50 cents (paper). 30 pp. 1952.

THE NATURAL MAN *As Inferred Mainly from Field Studies of Men and Chimpanzees. Doubleday Papers in Psychology.*

By Clarence Leuba. Doubleday & Company, Garden City. 95 cents (paper). x + 70 pp. 1954.

HUMAN BIOLOGY

A BIBLIOGRAPHY OF PHYSICAL ANTHROPOLOGY IN LATIN AMERICA: 1937–1948.

By T. D. Stewart. The Wenner-Gren Foundation for Anthropological Research, New York. (Paper). vi + 59 pp. 1952.

MEASUREMENTS OF SOME PREHISTORIC DESIGN DEVELOPMENTS IN THE SOUTHEASTERN STATES. *Anthrop. Pap. Amer. Mus., Vol. 44, Part 3.*

By James A. Ford. American Museum of Natural History, New York. Pp. 313–384 + 10 folded charts; text ill. 1952.

THE INDIAN CASTE OF PERU, 1795–1940. *A Population Study Based Upon Tax Records and Census Reports. Bull. Inst. soc. Anthrop. Smithson. Instn., No. 14.*

By George Kubler. Smithsonian Institution, Washington. 75 cents (paper). v + 71 pp. + 1 pl.; text ill. 1952.

COMPARABILITY OF STATISTICS OF CAUSES OF DEATH ACCORDING TO THE FIFTH AND SIXTH REVISIONS OF THE INTERNATIONAL LIST. *Bull. World Hlth Org., Suppl. 4.*

World Health Organization, Geneva. 50 cents (paper). 59 pp. 1952.

BIOMETRY

STATISTICAL THEORY WITH ENGINEERING APPLICATIONS.

By A. Hald. John Wiley & Sons, New York; Chapman and Hall, London. $9.00. xii + 783 pp.; ill. 1952.

STATISTICAL TABLES AND FORMULAS.

By A. Hald. John Wiley and Sons, New York; [Chapman and Hall, London.] $2.50. 97 pp.; ill. 1952.

This book might be regarded as an advanced text, but it is much more extensive and thorough than most text books. Free use is made of ordinary integral calculus, but more modern and powerful methods, such as generating or characteristic functions, are not used. There are good chapters on chi-square, distribution of the range, distribution of the variance ratio, the analysis of variance, two-dimensional normal distributions, multidimensional correlation, the Poisson distribution, and a few pages on sequential analysis. The distribution of chi-square and V^2 are derived, but the central limit theorem is stated without proof. There are no problems and the examples are not biological. This is an unusually satisfactory but not very exciting treatment of classical statistical methods. Tables and formulas appear in a separate paper-bound volume.

PAUL CRANEFIELD

STATISTICAL METHOD IN BIOLOGICAL ASSAY.

By D. J. Finney. Hafner Publishing Company, New York. $11.00. xix + 661 pp.; ill. 1952.

The author has written this book for the professional statistician and practitioner of bioassay, and it is not in any sense a simple or elementary treatment. The nonmathematical user of bioassays will, as the author remarks, find much of the book beyond him. Those sections listed as being of interest to the general reader include excellent material, in particular a chapter on the efficiency, reliability, and sensitivity of statistical tests; but they are scarcely sufficient to lead the general reader to purchase the book.

The book is an extensive and critical survey of the field, including much material on quantal response assays, on the author's own approach to probit analysis and good material on design. The mathematics is strictly classical, not encroaching on the field of modern mathematical statistics, and the general impression obtained is that the book represents a successful and valuable effort to establish valid procedures of bioassay in terms of classical statistical theory and its appropriate modifications.

PAUL CRANEFIELD

STATISTICS FOR MEDICAL AND OTHER BIOLOGICAL STUDENTS.

By L. Bernstein and M. Weatherall. The Williams & Wilkins Company, Baltimore. $4.00. xii + 180 pp.; ill. 1952.

Few books will serve better than this one as a biologist's introduction to statistics. Not only are the most useful statistical methods and problems (frequency distributions, averages, measures of scatter, sampling, chance differences, regression, correlation, transformations, and analysis of variance) explained in a clear way for the novice, but what is more, the pitfalls and valid uses of each are discussed. Particularly valuable, and most unusual in a textbook of this sort, are the two introductory chapters, on The Basis of Scientific Method and Probability, and the three last, on Experimental Design, Therapeutic Experiments, and The Interpretation of Observations. The book is in fact a statistical primer that is more concerned with the whys and wherefores than with turning out proficient statistical automatons. Prospective biologists and physicians will be challenged to go on to more advanced treatises, and what more can be asked of an introductory book?

The emphasis on tests of significance (t, χ^2) and on the analysis of variance demonstrates the modern trend in biostatistics. The necessary supplementary tables are included.

BENTLEY GLASS

CAMBRIDGE ELEMENTARY STATISTICAL TABLES.

By D. V. Lindley and J. C. P. Miller. Cambridge University Press, New York. $1.00 (paper). 35 pp. 1953.

Many students and research workers will be glad to have this inexpensive, yet exceedingly useful, set of tables. The first 8 tables give the Normal Distribution Function, Percentage Points of the Normal Distribution, Percentage Points of the *t*-Distribution, Transformation of the Correlation Coefficient, Percentage Points of the χ^2-Distribution, Conversion of Range to Standard Deviation, Percentage of the *F*-Distribution, and Random Sampling Numbers. Table 9 is the one that will probably be of greatest general service, since it gives in parallel columns certain functions of the integers up to 1000, namely, Squares, Square Roots, Reciprocals, Reciprocal Square Roots, Logarithms, Antilogarithms; and Inverse Circular and Hyperbolic Root-Sines (up to 100). Table 10 gives Logarithms of Factorials; and an unnumbered table of Proportional Parts is thrown in for good measure at the end. Values are given to 4 decimal places. The tables are largely derived from the *Biometrika* and other well-known tables, but with computation of certain additional values.

BENTLEY GLASS

DE OMNIBUS REBUS ET QUIBUSDAM ALIIS

BIOLOGICAL STAINS. *A Handbook of the Nature and Uses of the Dyes Employed in the Biological Laboratory. Sixth Edition.*

By H. J. Conn. Prepared with the collaboration of Various Members of the Biological Stain Commission. Revised with the Assistance of Elmer H. Stotz and Mary A. Darrow. Biotech Publications, Geneva. $5.00. 367 pp.; ill. 1953.

In 1922 a group of biologists organized the Commission on Standardization of Biological Stains, under the auspices of the National Research Council, with the purpose of testing and standardizing the stains used by biologists. In 1925 the chairman of this Commission, H. J. Conn, collected all that was known about biological stains at the time in the first edition of this book. Since then *Biological Stains* has become the standard reference work about stains and staining in theory and practice. This sixth edition brings it up to date, including the work in the last 7 years by the stain commission and by others.

New in this edition is the inclusion of histochemical reagents, an enlargement reflecting the rapid growth of this field in the last few years. We find also greater stress on methods of identification of stains. The inclusion of spectral graphs of nearly all the certified stains is a welcome addition. *Biological Stains* is so

well established through the five previous editions that nothing further need be said, except that whoever uses biological stains had better get hold of a copy.

HANS RIS

A PRACTICAL MANUAL OF MEDICAL AND BIOLOGICAL STAINING TECHNIQUES.

By Edward Gurr. Interscience Publishers, New York. $4.00. xx + 320 pp. + 1 pl. 1953.

Since microscopists began using stains and fixatives about a hundred years ago, innumerable formulae have been invented and modified, some of well established value, most of rather dubious worth. These recipes have been collected in numerous manuals as an aid to microscopists.

This new volume is strictly a list of formulae with short descriptions of procedures. It is organized into sections dealing with General Methods, including fixatives and embedding media, Animal Histology, Botanical Methods, Cytological Methods, Fluorescence Microscopy, and Smear Preparations. Within each section the formulae are arranged in alphabetical order of reagents or substances to be revealed by color tests. A few histochemical tests are thus included. The appendix contains atomic weights, conversion tables, formulae of most common fixatives and staining mixtures, refractive indices of common reagents, and solubility data of reagents and stains. A good index to the contents and a photograph of the author at work are included.

A practical manual such as this has some usefulness in the laboratory for quick reference. It would be easier to use if it were organized throughout in an alphabetical order, with cross references, as, for instance, in Cowdry's *Microscopic Technique in Biology and Medicine*. This would avoid the duplication in the various sections and the need to hunt through the index to find formulae that are not repeated but that are referred to in several sections.

HANS RIS

DE LA LOUPE AU MICROSCOPE ELECTRONIQUE. *Que Sais-Je? Le Point des Connaissances Actuelles, No. 453.*

By Jean Terrien. Presses Universitaires de France, Paris. 120 fr. (paper). 127 pp.; ill. 1951.

There is a great need in the English language for a small book of just this kind, dealing with the nature of the microscope and of microscopy in a lucid, semi-technical fashion within the limits of about 100 pages. Up to date, in that phase microscopy and electron microscopy are included, and illustrated with clear diagrams and line drawings, this book is the very thing for the beginner with the microscope. It provides that modicum of technical knowledge of the instrument and of the history of its development which is necessary to keep a novice from floundering. Perhaps someone will soon undertake to write a similar elementary treatise in our own language.

BENTLEY GLASS

A FRENCH-ENGLISH DICTIONARY FOR CHEMISTS. *Second Edition.*

By Austin W. Patterson. John Wiley & Sons, New York; Chapman & Hall, London. $6.50. xiv + 476 pp. 1954.

This is indeed a dictionary for chemists, but it is also such a useful and easy-to-use tool for the occasional reader of technical papers in French that the title is likely to deter non-chemists who might benefit greatly from using it. The inclusion of the first and third person forms of the commoner irregular verb forms is a great help to those of us who read technical French so seldom that we do not keep the conjugations clearly in mind. The typography is excellent; the various type-faces used are particularly easy to read. This book and its companion German-English volume by the same author have proven far more useful than any other dictionaries in these languages which I myself have had the privilege of using.

ROBERT L. PENDLETON

FRENCH BIBLIOGRAPHICAL DIGEST. *Science: Biology, Botany, Zoology. No. 9. (Series II).*

Edited by Georges Assié. The Cultural Division of the French Embassy, New York. Free upon request (paper). v + 100 pp. 1953.

This is the first issue of the second series, and is designed to present to American users a guide to the significant biological books published in France from the beginning of 1949 to some time in 1953. In addition to bibliographic information, many items are accorded a brief review reprinted from one of 7 review journals, 6 of which are French, the other being the *Quarterly Review of Biology*. The preface consists of an informative article on Botany in France Today, by Lucien Plantefol, Professor of Botany at the University of Paris. The booklet also contains a list of French scientific periodicals that contain biological material; a directory of publishers; and an author index. The sole obvious criticisms of this valuable bibliographic aid are, first, that biology is interpreted somewhat narrowly, a deficiency that other numbers of the series may be expected to supply; and second, that no prices are given. Even though prices may be expected to change not infrequently, some indication as to cost would be very helpful.

BENTLEY GLASS

ANNUAL REPORT OF THE BOARD OF REAGENTS OF THE SMITHSONIAN INSTITUTION, *Showing the Operations, Expenditures, and Condition of the Institution for the Year Ended June 30, 1952. Publication 4111.*

U. S. Government Printing Office, Washington. $2.75. x + 461 pp. + 43 pl.; text ill. 1953.

In addition to the usual annual reports of the branches of the Smithsonian Institution, among which those of the U. S. National Museum, the National Zoological Park, the Bureau of American Ethnology, and the Canal Zone Biological Area are of particular interest to biologists, this volume contains the customary excellent selection of semi-technical articles, mostly reprinted from various periodicals. Those of biological interest are as follows: Man's Synthetic Future (Roger Adams); Phosphorus and Life (D. P. Hopkins); The Ice Age in the North American Arctic (Richard Foster Flint); Snails and their Relation to the Soil (Harley J. Van Cleve); The Ecology, Evolution, and Distribution of the Vertebrates (Austin H. Clark); Grasshopper Glacier of Montana and Its Relation to Long-Distance Flights of Grasshoppers (Ashley B. Gurney); Recent Advances in the Study and Techniques of Anatomy (Paul G. Roofe & Samuel W. Lesher); Livestock Parasitology in the United States (Benjamin Schwartz); Botanizing with the Okinawans (Egbert H. Walker); Bromeliad Malaria (Lyman B. Smith); Pharmacology of Antibiotics (Henry Welch); An Anthropologist Looks at Lincoln (T. D. Stewart); and The Use of Music in the Treatment of the Sick by American Indians (Frances Densmore). The articles by Clark, Gurney, Walker, Smith, and Stewart are here published for the first time.

CATALOGUE DE LA BIBLIOTHÈQUE DE L'I. E. C. (*Matières, Auteurs et Périodiques*). *Mémoires de l'Institut d'Études Centrafricaines, Brazzaville (A.E.F.), No. 4.*

By Jeanine Lambert. Imprimerie Charité, Montpellier. 1,000 fr. (paper). 153 pp. 1950.

PHOTOGRAPHY THROUGH THE MICROSCOPE. *Eastman Kodak Company, Rochester.* 50 cents (paper). 68 pp.; ill. 1952.

ECOLOGY

Official Publication of the ECOLOGICAL SOCIETY OF AMERICA
Continuing the Plant World

Editors:

Edward S. Deevey (Zoology), Yale University **W. D. Billings** (Botany), Duke University

Vol. 35, No. 3 *CONTENTS* July 1954

The hydrobiology of Atwood Lake, a flood-control reservoir ..... *John C. Wright*
An analysis of the spruce-fir community on the Kaibab Plateau, Arizona ..... *John Merkle*
Factors controlling the distribution of oysters in a natural estuary ..... *Nelson Marshall*
Evidence of four pine species from fossil pollen in Michigan ..... *John F. Grayson*
Quantitative studies of protozoan populations from two areas of Pymatuning Lake, Pennsylvania ..... *Howard D. Orr*
Ecology of the Opuntiae in the Big Bend region of Texas ..... *Margery Anthony*
Cell contents of nitrogen and phosphorus as a measure of their availability for growth of *Microcystis aeruginosa* ..... *Gerald C. Gerloff and Folke Skoog*
Climates of the Great Smoky Mountains ..... *Royal E. Shanks*
Equations descriptive of fish schools and other animal aggregations ..... *C. M. Breder, Jr.*
Soil phosphate and the delimitation of plant communities in eastern Australia ..... *N. C. W. Beadle*
The ecological distribution of the *Peromyscus leucopus* species group in eastern Texas ..... *W. H. McCarley*
Soil mantle movement in relation to forest clearing in southeastern Queensland ..... *Lincoln Ellison and J. E. Coaldrake*
Mortality rates of whitefish in an arctic lake ..... *Donald E. Wohlschlag*
The influence of shade and litter of pine on evaporation from a clay loam soil at Berkeley, California ..... *Joseph Kittredge*
Ecological studies of forest trees at Chalk River, Ontario, Canada. I. Tree species in relation to soil moisture sites ..... *Donald A. Fraser*

NOTES AND COMMENTS REVIEWS

Orders should be placed with
Duke University Press
College Station Box 6697 Durham, North Carolina

Annals of Human Genetics

(FORMERLY ANNALS OF EUGENICS)

Edited by L. S. PENROSE *with the assistance of*
JULIA BELL, R. A. FISHER, J. B. S. HALDANE, MARY N. KARN, R. R. RACE, J. A. F. ROBERTS

Vol. XIX. Part 1. July 1954.

The Pelger-Huët anomaly. Investigation of Family 'A'. W. M. DAVIDSON, A. G. ACKERLEY AND SYLVIA D. LAWLER.

The distal triradius t on the hands of parents and sibs of mongol imbeciles. L. S. PENROSE.

Notes on sickle-cell polymorphism. A. C. ALLISON. With statistical appendix by Sheila Maynard Smith.

The effect of the age and parity of the mother on the birthweight of the offspring. JEAN MILLIS AND P. S. YOU.

Reviews.

SUBSCRIPTION (payable in advance) *$9.50 per volume of 4 parts.*

NEW ISSUES OF THE GALTON LABORATORY
EUGENICS LABORATORY PUBLICATIONS—MEMOIR SERIES

XXXVI Race crossing in Man. The Analysis of Metrical Characters. By J. C. TREVOR, Ph.D. Price $2.50.
XXXVII An Introduction to Human Biochemical Genetics. By H. HARRIS, M.D. Price $2.75.

***Issued by the* CAMBRIDGE UNIVERSITY PRESS**

32 East 57th Street, New York 22, N. Y.

(In writing to advertisers, please mention the journal—it helps.)

SANS TACHE

The book to read

before you write . . .

153 pp.

9 figs.

$1.50

· AUTHOR · PUBLISHER · COMPLEX · PRINTER ·

By Robert S. Gill

SECOND EDITION

Contents. . .

The Concepts Printing and Publishing
Purpose and Plan of This Book • Printing and Publishing: A Contrast • The Publisher's Function • When Is a MS Publishable?

The Author and Printing Processes
First Stage • Second Stage • Third Stage

Form Suitable
What the Publisher Hopes to Find • Causes of Form Not Suitable • Final Reading • Verbal Bums

Fair Copy
The Typescript • Headings and Subheadings • References • Legends, Footnotes, Bibliography • Consistency • Quotations • Permissions • Punctuation • Phrases to Avoid • Pagination • Correction of MS • Three Useful Tools

Illustrations
Some Unnecessary Procedures • Graphs and Charts • Half-Tones • X-ray Film or Print • Color • Plates • Grouped Illustrations • Reduction • Clippings, Borrowings, Permissions • Legends • Numeration • Final Reading

The Ends and the Oddments
The Minor Prelims • Preface and Foreword • Table of Contents • Supplementary Lists • Bibliography • Other Incidentals • The Index

The Reading of Proof
Exchange of Proof • Authors' Alterations • Galley-Proof • Proofs of Illustrations • Page-proof

Revision
Errata • Reprinting • General Remarks on Revise • Revise, No Type Standing • Revise from Standing Type • Revise from Electroplates

Literary Property and Inheritance
Property-right and Copyright • Literary Inheritance • Literary Successorship • Literary Heir • Publishing Agreement and the Author

Royalties and Such
Bases of Royalty • Sliding Scale • When Is a New Edition? • Remainder Clause • Author's Copies • Royalty Payments

The Author as Co-Publisher

THE WILLIAMS & WILKINS COMPANY
Mt. Royal and Guilford Aves. Baltimore 2, Maryland

(In writing to advertisers, please mention the journal—it helps.)

THE QUARTERLY REVIEW OF BIOLOGY publishes critical reviews of recent researches in all of the special fields of biological science. The contribution should present a synthesis or digest of the researches and a critical evaluation of them. A mere synopsis of the literature without evaluation or synthesis is not desirable.

Theoretical papers are published occasionally, especially when such papers (1) include a critical synthesis of the literature bearing on the theory and (2) are likely to promote further research in a given field.

The article should be written in concise language, yet in sufficiently non-technical form as to be intelligible not only to specialists in other fields but to the general biologist as well. To this end the article should have a general introduction and a summary which enumerates one by one all of the principal facts and conclusions given in the paper. Interpretative diagrams and schemes are very desirable.

Material ordinarily taking the form of footnotes is set in small print and placed in the text and consequently should be written in a style so as to fit readily into the text. Acknowledgments are printed in the text in small type at the end of the article just preceding the List of Literature. Recent issues of the Quarterly should be examined for style as regards (1) section or subsection headings in the text, (2) literature citations in the text, and (3) List of Literature.

The subjects and authors of articles are selected by the Editors and members of the Advisory Board. Unsolicited articles which conform with the objectives of the Quarterly will be considered for publication.

A feature of the REVIEW is the section dealing with *New Biological Books*. In this department the book literature of different countries in the field of Biology is given prompt notice.

The QUARTERLY REVIEW OF BIOLOGY is issued in March, June, September and December.

Twenty-five reprints, with covers, of articles will be furnished to contributors free of cost. The reprint order blank accompanying galley proofs gives the cost of additional reprints.

Manuscripts may be sent to Dr. B. H. Willier, Department of Biology, The Johns Hopkins University, Baltimore 18, Maryland.

Books for Review may be sent to Dr. H. B. Glass, Department of Biology, The Johns Hopkins University, Baltimore 18, Maryland.

New subscriptions and renewals are entered to begin with the first issue of the current volume. Should any issue of the current volume be out of print at the time the subscription order is received, the pro-rata value of such numbers will be refunded to the subscriber.

Subscriptions should be renewed promptly—To avoid a break in your series, subscriptions should be renewed promptly. The publishers cannot guarantee to supply back issues on belated renewals.

Subscription price: $6.00 United States and countries within the Postal Union; $6.50 countries outside the Postal Union. Single copies will be supplied, when available, at the rate of $1.75 a copy.

Claims for copies lost in the mails must be received within 30 days (domestic).

Changes of address—Publisher must be notified 60 days in advance. Journals undeliverable because of incorrect address will be destroyed. Duplicates can be obtained (if available) from the publisher at the regular price of single issues.

THE WILLIAMS & WILKINS COMPANY

Publishers of Scientific Books and Periodicals

BALTIMORE, U. S. A.

CONTENTS

Morphogenesis in Protozoa
—*Paul B. Weisz* (207–229)

The Life-History and Systematic Relations of the Mesozoa
—*Horace W. Stunkard* (230–244)

New Biological Books
New Directions in Genetics
—*Ernst Caspari* (245–247)

Reviews and Brief Notices (248–305)